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MARCH 1958

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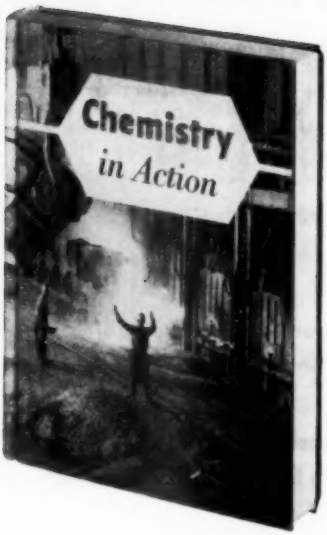

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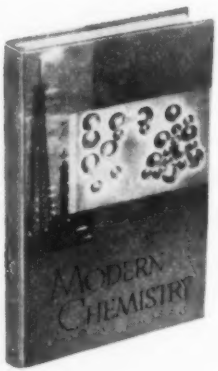

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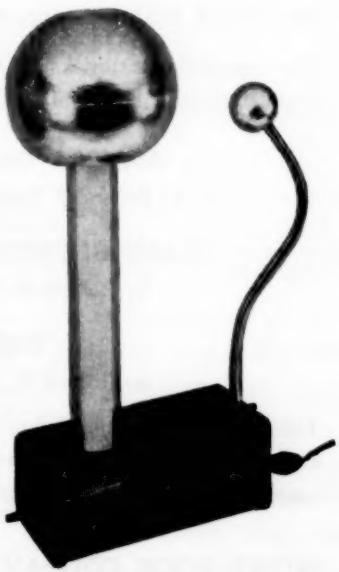

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THE CHALLENGE OF SCIENCE AND MATHEMATICS IN A FREE WORLD

LOUIS PANUSH

President, CASMT, Henry Ford High School, Detroit, Michigan

The *Central Association of Science and Mathematics Teachers* has recently gone through one of the most satisfying experiences in its long and distinguished history. I refer to the 57th annual convention held in Chicago last Thanksgiving recess. It was one of the most suc-

LOUIS PANUSH, President of CASMT

cessful conventions ever held by the Association, both in quality and quantity. About 1000 people attended; they oversubscribed the tour to the Argonne National Laboratory and crowded the tours to the Planetarium, the Museum of Natural Science, and the Museum of Science and Industry; they participated enthusiastically in all the general sessions, including the business meeting, and in the section meetings. They stayed on later than usual on Saturday afternoon, and many were reluctant to leave. The innovations and some of the unique features introduced in the program not only met with approval but elicited a demand that they be incorporated in future convention programs.

A dynamic convention of this type could not have been held without the enthusiastic support of a large number of fellow Association members. Thanks and appreciation are again expressed to our immediate Past President, Edward Bos, whose continuous efforts and encouragement kept the "ball rolling and the wires humming"; to Neil Hardy, general co-ordinator and Local Arrangements Chairman, whose organizational skill was evident everywhere in a smoothly functioning convention; to Ray Soliday, the untiring keeper of the treasury and business office, whose advice, experience and careful pre-planning were invaluable; and to the Board members and all section officers who cooperated and gave much time and energy to prepare most worthwhile programs.

The Association met during a critical period in the history of American education. It met at a time when the earth acquired two temporary satellites and great pressures were exerted on American scientists and engineers to put our own satellite spinning around the earth in order to prove to the world that our scientific accomplishments, know-how and "genius" are at at least equal to, if not by far better than, Soviet Russia's. In the American-Russo science race, our high school educational system took a harsh beating in the press and in the addresses of eminent speakers on the subject. Our convention took cognizance of the problem of scientific education and the place of science in our national life in the provocative and masterful address of Dr. Urey and in the discussions on educating our gifted and talented students in science and mathematics. This was but a small beginning. The challenge still remains, and our Association has to take a strong and positive stand in advocating and promulgating a program of scientific and mathematical education that will meet both the needs of the general students who should become the intelligent citizens in the age of science and of the able and talented students who will specialize to become the scientists, mathematicians, engineers, and researchers to meet the urgent needs of our scientific society.

Therefore, the leaders of the Association have set as the theme of the 1958 convention, to be held in Indianapolis, Indiana, "The Challenge of Science and Mathematics in a Free World." It will be the aim of the program, probably patterned after the successful 1957 structure, to explore, analyze and evaluate the means and methods by which the challenge can be met on the elementary, junior high, high school, and junior college levels in the areas of science and mathematics. We shall have to re-examine our objectives, identify the problems that face us, chart a course to be followed, provide the framework for future action, and make sure that our resolutions are implemented. Thus will the CASMT make a positive and effective contribution to the scientific education of our youth. Ours is the challenge and we have to meet it.

At the open Board meeting, in discussing the future of CASMT, Dr. Milton Pella, a Past President of the Association, made a number of very worthwhile suggestions which will lead the organization to growth and creativity. He also emphasized that our Association must take a stand on the following issues: (1) Teacher certification in science and mathematics; (2) the nature of the curriculum in science and mathematics for the average and superior pupil in the high school; (3) the nature of types of facilities needed in the high school; and (4) the nature of the content of the present science and mathematics courses. All of his suggestions will be given careful consideration and there will be some definite action undertaken by the present leadership.

At our last convention, a new plan for nominating and electing officers and Board members was decided upon. Our leaders will no longer be elected at the annual business meeting at the convention. It will now be the responsibility of every member of the Association, whether or not he attends the annual convention, to chose the leadership in whose hands he wants to entrust the future of his Association. We shall be looking forward to an enthusiastic response by the membership when they will be asked to propose nominees for offices and later mark the ballots. We are sure that the response will be wholehearted.

Your President is grateful for the trust placed in him, and he is aware of his responsibilities. He hopes to live up to them and add his contribution to the dynamism and growth of CASMT.

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SOME OBSERVATIONS ON EDUCATIONAL PROBLEMS IN THE UNITED STATES WITH PARTICULAR REFERENCE TO MATHEMATICS AND SCIENCE*

DR. HAROLD C. UREY
The Enrico Fermi Institute for Nuclear Studies, University of Chicago, Chicago, Illinois

1. INTRODUCTION

Recent events have emphasized to the people of this country in a most dramatic way that another country, whose political system we do not like and whose aggressive world policies cause fear among the western democratic countries, can and has produced scientific and engineering feats of a most remarkable kind. Also, the facts are obviously such that espionage of our scientific and engineering knowledge cannot explain these most recent events. It is necessary in fact to face up to the fact that the vaunted and smug assumption of superiority with respect to inventive genius and "know how" has serious cracks in its armor and that we must appraise our own position critically. Either this is true or our competitor and prospective adversary, as freely admitted on both sides of the famous curtain, has the most remarkable espionage system ever invented, namely it can steal secrets that we do not have or are quite unable to develop and use effectively. After some resistance on the part of the witch-hunting fraction of the population we will settle down to understand our faults and shortcomings and do what needs to be done to correct the situation.

But what needs to be corrected? Our security system? Nonsense! I am sure that no espionage that has come to our attention throughout the years since the war was of any critical importance to these scientific and engineering events. Our support for science? I believe not in any immediate way. We have many outstanding scientists and they have been adequately though not handsomely supported. It is certainly not a failure of our industrial plants and facilities nor any lack of raw materials or of manpower. All the necessary things can be done without any serious lowering of our standard of living.

I wish to say that the immediate answer to the question of what is wrong is, "Nothing." Some fumbling in Washington which should not be underestimated has occurred, but most probably we are ahead of our competitors at the present time in scientific work and technical development. We almost certainly lag in certain critical missile development and we cannot dismiss an antagonist that openly declares its aggressive intentions from our minds. But the general situation is not

* A paper presented at the General Session at the Convention of the Central Association of Science and Mathematics Teachers, Friday evening, November 29, 1957, Congress Hotel, Chicago, Illinois.

determined by the results of bad judgements in one field during the past few years. Moreover, I think that an aroused public opinion and a critical Congress will result in proper efforts to correct the immediate situation as soon as possible. We all hope it will be soon enough.

2. The Real Problem

The real problem that faces the country is a long term one. It is a problem of the proper education and inspiration of our youth.

It is often emphasized that we owe much to brilliant scientists born and trained abroad for the development of atomic energy during the war and this is true. (Parenthetically may I say that we owe much to native born and trained scientists as well and it might provide some inspiration to our youth if this was recognized more explicitly from time to time.) Also, if we study the origins of many of our famous professors, we find that many of them are foreign in origin. The same is true of younger staff members and also of fellows and students. This is true of the Enrico Fermi Institute of Nuclear Studies and it is true of other institutes that I have visited recently. Why is it that this country of 172 million people, all of whom have gone to our universal public school system, still depends to such a large extent upon foreign sources for some of its most effective scientific intellectuals? What does this situation bode for the future?

I believe that this does not indicate that Americans are an inferior strain of Homo sapiens. The Nobel Prizes are generally considered to be an index of the general level of intellectual competence. An increasing number of these prizes in the sciences have gone to United States citizens, but many of these received their training abroad. While it is unlikely that immigration to the United States resulted in any important biological selection of unintelligent people, it is probable that the particular problems of conquering a wilderness emphasized other types of activities than intellectual ones. On the other hand the settled and civilized communities of Europe attached a much greater emphasis on intellectual activities and this has persisted up to the present time. The U.S.S.R. has imitated western Europe in these matters rather than the United States. The United States is no longer a wilderness of wild animals, of hostile and primitive native people without roads, farms and cities. It must now face competition with highly intelligent people who have trained and are training many people in effective disciplines which are only acquired by long and patient study.

3. Our Educational Problem

In discussing our educational problem before a group who has devoted their lives to teaching, I am very well aware of a lack of any

specific knowledge of its detailed problems. I could not teach the fifth grade, nor geometry in high school nor any other subject on any other level except a few subjects on the college level and can make many errors in discussing the subject. However, as a teacher in college subjects I have been receiving and teaching the product of our secondary schools for many years. Also, I have a sister, a couple of brothers-in-law , a daughter, nephews and neices who are teaching in primary and secondary schools and perhaps am not wholly unaware of these problems because of these connections. But most of all, I presume to discuss this problem because of its very great importance and let me urge all others to try to formulate constructive criticisms of our present activities with respect to the training of our youth in the hopes that constructive improvement can be made. Remember, the incompetent eventually go under in this world either in war or in peaceful competition.

Some fallacious assumptions have been made in modern educational policy and some of these have been made with the best intentions. Some of these have been made by the community. Thus, compulsory school laws require that children shall remain in school until age, X, where X is an increasing function of time. Compulsory school laws are evidently desirable, but the belief that the higher the age limit, the better, is fallacious. Closely related to this fallacy is another, namely that no child may do useful work until after age, Y, another increasing function of time. Obviously child labor laws are desirable. However, it is much easier to enforce prohibitions than proper supervision. First of all we must recognize that there is considerable variation in capacity of children to profit by increased attendance at school. It is probably fortunate that this variability exists because of the wide range of tasks needed in a modern community. The age limits for both compuslory education and for child labor laws should be reconsidered. Our schools should not be used as a means of keeping teenage children off the streets, out of the corner pool room, and out of the juvenile courts. After all, a certain amount of productive activity is good for young people.

Another fallacy of the community and acquiesced in willingly or reluctantly by professional educators is that all children regardless of capacity must be given the same basic education. The superior child is required to adjust his pace to that of the less capable child because the reverse adjustment is impossible. Recently my attention was called to a child with an I.Q. of 145 sitting in a class of 33 children under one teacher. That teacher could not possibly give him adequate attention and he just "sat there." (The quotes are the words of the teacher.) That child is having indolence forced on him and he is losing knowledge that he might gain. Is this the reason that the seminars at the University of Chicago have so many foreign born and

trained scientists listening to so many teachers and professors of similar training? I believe that this incident multiplied by 10^5 or 10^6 is definitely the primary reason for the situation.

There is much discussion of desegregation in American schools. There are, in fact, two problems: one of desegregation based on minor physical variations, *i.e.*, color, and another of segregation based on inherent intellectual capacity. Both color and intellectual capacity are things we acquire at birth or, indeed, at conception and there is nothing we can do about either except to accept our lot with some fortitude and do the best we can with what we are and can achieve. We have a right to insist on equal opportunity within our capacities but all of us will lose if we are not willing to train and profit from this training of the most intelligent members of the community.

Another fallacy of recent educational philosophy is that the purpose of education is to develop the personality of the individual, not primarily to acquire knowledge. I disagree with this completely. The primary purpose is that the acquisition of knowledge and in fact, the most important requisite of an attractive personality is knowledge, knowledge of something definite, knowledge that is extensive and complete. Such knowledge does not exclude the possibility that a person possessing it shall not be able to enjoy light conversation at the proper time or place, or that he have other interesting capacities. Most of these capacities are a hollow shell, if there is not a solid core of exact knowledge acquired by diligent study mostly in our educational insititutions at least in the present century.

Then there is the fallacy that each year of the study shall be organized as though it were to be the last of the students' intellectual pursuits. All of us know that acquiring knowledge is a long process in which year after year each of us adds to and broadens his previous knowledge. To acquire an effective modern education requires some fifteen or twenty years of systematic effort and the curriculum must be planned with the whole period in view. Again segregation is necessary if such planning is to be effective. It is not possible to plan an effective curriculum for the boy going into some trade and at the same time make the curriculum a satisfactory one for a future professor of mathematics or astronomy. Last year I was at Oxford University and there learned of the examination taken by children at eleven years. The grade on this examination, which is nationwide, determines whether the child is going into some trade or on to academic studies. Parents, children and teachers live with this examination in mind and every consideration is given to preparing for it. I have seen some of these papers written by eleven year old children and must compare certain examination papers written by American college students unfavorably with them.

But this leads to other curious ideas about education. For example,

that the child shall never face a definite test of attainment nor be required to face the disappointment of a failure—except if he desires to be an athlete, of course. In this latter field, no soft-hearted consideration is given to the little fellow who cannot make the Varsity. Now, we all eventually face such tests and disappointments and, in fact, they are a necessary part of planning our lives. It is no kindness to let a child think that he can follow one kind of activity when he would only be a failure in it. If he cannot become a mathematician, it is well that he adjust to what he can do, say, being an expert mechanic, and that he do this early rather than late.

4. The College Student

In spite of the many faults which have been mentioned, some good students arrive at our colleges and universities, diluted, however, with the very many who are not. I will list a few of the common faults. Their spoken and written English is very limited, they have little knowledge of grammar and their vocabularies are small and filled with slang. (The English child at eleven was better than many.) Their mathematics is weak. Most do not understand simple proportions. Their knowledge of languages, science, literature is inadequate. They have no effective study habits. (I learned mine in the fifth grade.) They have little idea of thoroughness, of trying to acquire complete knowledge in anything. Very often their intellectual interests are very slight. They read no books or serious magazines and seldom engage in serious conversations.

The pattern is not universal, but is true of a large proportion of students going to college. Most should never have gone. They will join that great group of college graduates who have no intellectual interests, who never acquire a modest library and who repeat the slogans of their associates as a substitute for thinking. It is my opinion that there are too many people admitted to our colleges and universities at the present time unless better preparation and incentives can be instilled into many of the present college population by some methods at present unknown or at least not practiced.

5. Some Definite Suggestions

1. We should reconsider the compulsory school age and the minimum age for child labor laws. We should face the difficulty of adequate inspection of working hours and conditions for teenage workers.

2. We should keep the schools open for ten months per year, 5.5 days a week, and the school day should be six hours and homework should be regularly required.

3. Children should be segregated on the basis of capacity and properly trained teachers should be given to all groups.

4. Increased financial support is required for our schools. The buildings should be substantial, but need not be luxurious. The foot ball field and gymnasium have been overemphasized in the past. The number of classrooms should be adequate for full time attendance of all children and the number of children per room should not exceed twenty-five.

5. We need more and better teachers. This means that pay of teachers should be increased until many of our college students will find teaching an honorable, respectable calling with appropriate salaries. I believe that the school budget of this country should be approximately doubled and that the increase should go for the purposes I have indicated and not to gaudy non-essentials.

6. Obstacles to Such Suggestions

Among the obstacles to such a program are first of all—let's face it—teachers. So many have been trained for so long in these curious ideas as to the purposes of education and its methods, that great resistance to any change will be encountered. We have entrenched interests in our teacher's colleges and official administrators and any change will be won only by great effort. But allies still exist within the teaching profession!

Parents and the public generally will be opposed in various ways. Many do not wish to have junior's precious ego exposed to the realities of life. They will pack his ego, and their own incidentally, in cotton and never face the fact that he is not an Einstein because he is a darling. Also the idea of increasing school budgets has no appeal of a popular kind. The excess gaudy chrome of the family car, its engine with approximately twice the power needed will be regarded as necessities. Yet economies on such completely unessentials would pay the increased school budget proposed. The vested interests of the automobile industry and its sales agents would be violently opposed. Well, industry has been proposing that its engineers and scientists help local high schools with their teaching programs. Very well, I am only proposing that various employees be transferred to the high schools at full pay at salaries equivalent to that paid by the company. Janitors, architects, building personnel, and teachers are all needed. We are only suggesting that mathematics in high school is probably even more interesting than drafting boards and that a bright youngster is more important and a more gratifying product than the grotesque monstrosity known as the 58 model. If we wish to have better schools we must transfer personnel of many kinds from other activities to the school system and this means transferring people of many capacities including many with intellectual interests to this important field.

Ah! But do we really wish to do this? "To be or not to be. That is the question." Aren't we largely a nation of anti-intellectuals? Don't we really mistrust these people who are so much smarter than we are? Aren't they subversives or communists first of all? It seems to me that the population of this country has a considerable predilection for trusting essentially stupid people and mistrusting those who are brilliant.

Well Sputnik I and II pass over this city regularly. They were launched by very intelligent men. They are probably able to launch missiles of great destructiveness. Whatever the faults of their country may be, its people have great respect for their scientists and other intellectuals. We and the peoples of other democratic countries must look to our intellectuals for help in these dangerous times. Possibly our anti-intellectualism is something which could kill us all.

SUDDEN FALL INTO COLD WATER CAN CAUSE DEATH

A sudden fall into cold water can kill a person or cause him to lose consciousness, especially if he enters the water after a heavy meal.

Scientists tested the effects of sudden cold exposure by having human test subjects climb, fully clothed, into a tub of water only a few degrees above freezing. Other subjects wore only bathing trunks and were hosed down with cold water so the effects on the blood pressure in their veins could be recorded.

The sudden cold caused the veins to begin closing down and this caused the blood pressure in them to go up. The pressure in the arteries also climbed and, as a result, the heart had to work doubly hard to do its job.

This increased strain on the heart may explain who exposure to cold brings on attacks of angina in heart patients. There, the blood supply is already below normal in the heart, and any further lowering creates painful symptoms.

Vein constriction may also explain the death of people who have been found dead in cold water, yet who showed none of the classical signs of drowning.

40% OF ACTIVE TB CASES ARE STILL UNRECOGNIZED

The latest official survey of TB cases in the United States has shown that almost 40% of the active cases are still unknown to medical and health authorities and are not receiving any type of care.

Although the number of active cases has declined almost 30% in the past five years, there are still 250,000 persons with the disease in its active form.

The number of "unknown" cases is estimated from the number of previously undiscovered cases that are found in X-ray surveys. The survey also showed that in 1956 some 2,000,000, or one out of every 85 persons in this country, were either ill or had been ill with tuberculosis.

Of these 2,000,000 persons, there are 250,000 with active tuberculosis, another 550,000 with inactive tuberculosis who require continuous supervision by health departments, and 1,200,000 who once had active TB but for whom public health supervision was less urgent.

In 1952, there had been 350,000 active cases of tuberculosis and 600,000 inactive cases.

THE CO-OP EDUCATION PATH TO A CAREER IN ENGINEERING AND SCIENCE

OPPORTUNITIES AND COUNSELING IN THE CO-OP PROGRAM OF THE BUREAU OF SHIPS

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EMERGENCE OF A NEW PROGRAM

There are times in the history of industry-education relations when new frontiers are cracked. Such occasions come into sharp focus when there is a persistent national demand for educated manpower and a continuing search for promising youth. The frontier cracked is generally not anything startlingly new—rather, it is often some new adaptation or exploitation of a time-tested and well established educational program. In this case the time is 1956–1957; the educational program is the co-operative education plan combining work and study in an integrated pattern; the "industry" is the Bureau of Ships (the largest engineering and technological organization within the Department of the Navy); the "schools" represented include many high school systems on the east and west coasts and a considerable number of participating engineering colleges; and, the frontier is an adaptation of the co-operative education plan to include new features and opportunities. This is the setting.

The initial target is a five-year program, 1957–1961, and it is hoped that the program will be built in, eventually, as a permanent instrument for assuring an annual in-put of promising young people interested in careers in engineering and science. The highlights of the program are described in this article in terms of the broad precepts and the administrative features, for the interest of professional personnel and guidance workers in high schools, junior colleges, and colleges. The principal purpose of this account, however, is to keynote the main features of the program and the strong element of counseling throughout the program.

An intensive first year in publicizing the new program for a national audience involved many meetings with high school counselors, school officials, and other educators, presentations before high school students at assembly exercises and special career clinics, several regional conferences and publication of the proceedings of these important conferences, the use of media such as local newspapers and the general press, radio, visits, special brochures, and publicity through civil service announcements in the various regions of the United States. These efforts were well rewarded. More than 5,000 promising youth, with high academic standing in their high school graduating class and motivated toward professional careers in engi-

neering and science, responded to the publicized opportunities offered in this program and qualified for entry in the Bureau of Ships—Field Activities Co-op Program in Engineering and Science. As the college year opened in September, 1957 some 550 of the candidates in this competition were selected as co-op student-trainees in the program. In this work-study program they are pursuing study programs through enrollment in one of the 40 participating colleges, alternated with work assignments at quarterly or semester periods in the place of employment—and the integrated program leads to a Bachelor's degree in their field of specialization. The career fields are well distributed—electrical, civil, mechanical, electronic, marine, chemical, metallurgical, nuclear, and other branches of engineering; naval architecture, as a special and principal field; and, physics, mathematics, chemistry, electronics science, and other sciences.

Features

The pictorial chart presents the general pattern of the Bureau of Ships—Field Activities Co-op Program in Engineering and Science. It indicates the sequence and the progression from the point of entry into the program to graduation. This is reinforced by the following expression summarizing the main features of the co-op program of the Bureau of Ships:

*—A five-year academic program leading to the Bachelor's degree in engineering or science, followed by a special three months work period for promotion to the GS-7 grade;

*—Undertaken in partnership with accredited colleges, and with special emphasis on co-op institutions represented in the Cooperative Education Division of the American Society for Engineering Education;

*—Blocks of alternating periods between college studies and employment in the naval activity to be in terms of a quarter, semester or other academic calendar period of the particular institution in which the student-trainee is enrolled;

*—Wide range of selection of field of specialization in engineering or science, and enrollment in the co-op institution in the nearest geographic area where such a curriculum is offered or can be arranged;

*—Participating student-trainees to be selected, principally, through the initiative and effort of the naval activities in their respective geographic areas; and, subject to acceptance by the Civil Service Commission (through attainment in the competitive examinations) and by the college (through evaluation of high school transcript and college entrance requirements);

*—Source of recruitment to be, principally, prospective or recent high school graduates who rank in the upper quarter or third of their class and who have high motivation and educational potential for undertaking studies toward an engineering or science career;

*—Special emphasis on attracting high school graduates who, by their family, community, or other relationships, would be interested in employment as subprofessional assistants while pursuing their college studies and, upon graduation, as full-time professional engineers or scientists;

*—Standard pattern of promotion and grade progression of the student-trainee, from grades GS-2 to GS-7, through a Special Promotion Agreement approved by the Central Office of the U. S. Civil Service Commission; present salary range is as follows: GS-2 ($2,960) to GS-7 ($4,595), with the student-trainee earning approximately one-half the annual salary during his half-year period of employment, and in a non-pay status while attending college for the other half-year period;

*—Extent of educational assistance available to the student-trainee approaches 40% and not to exceed 50% of his total tuition and related educational costs during the five-year period, and is available to those who indicate their desire for such "scholarship" assistance and agree to an equitable employment period upon graduation;

*—"Co-op Student-Trainee Profile Card" is maintained for each student-trainee in the program, to follow his progress and to expedite the counseling function;

*—The sequence of work assignments, throughout the course of the five-year program and the special three-months period after graduation, is such to assure use of the student-trainee's knowledge and abilities at progressively more difficult and complex levels of sub-professional and ultimately professional work;

*—Built-in system of counseling and guidance through counseling services at both ends: at the naval activity where he is employed, counseling by the Training Superintendent and the supervisors to whom assigned in the engineering or scientific unit; and, at the college by the Coordinator of the co-op program or selected professors or both.

It is anticipated that other features will develop as they show promise of being advantageous to the student-trainee and to the naval activity.

The roster of participating colleges in this program includes the following, among the forty colleges in the program; Stanford University, Pratt Institute, Fenn College, University of California, University of Michigan, University of Pennsylvania, Georgia Institute of Technology, Northeastern University, California Institute of Technology, Virginia Polytechnic Institute, University of Hawaii, and others. The full roster includes engineering colleges, liberal arts colleges with pre-engineering or pre-science programs, and junior colleges affiliated as the lower division of a larger university system in which students can then enter the upper division.

The Co-op Education System: A Restatement

For orientation regarding the co-op education plan it is well to draw upon the definition and mode of operation as described by the U. S. Office of Education.[1] Basically, the co-operative plan is defined as an integration of classroom work and practical experience in an organized program under which students alternate periods of attendance at college with periods of employment in industry, business, or government. The employment constitutes a regular continuing and

[1] "Co-operative Education in the United States, by Henry H. Armsby. U. S. Office of Education, Bulletin 1954, No. 11.

essential element in the educational process, and some minimum amount of employment and minimum standard of performance are included in the requirements for a degree. The plan requires that the student's employment be related to some phase of the branch or field of study in which he is engaged, and that it be diversified in order to afford a spread of experience. It requires further that his industrial work shall increase in difficulty and in responsibility as he progresses through his college curriculum, and in general shall parallel as closely as possible his progress through the academic phases of his education. This is essence, is the definition of the plan.

With regard to the means by which this plan is pursued, the co-operative plan generally operates as follows: A full-time job is obtained in an industrial concern or governmental agency, preferably near the college concerned. This job is shared by two students, one of whom works on the job while his partner or "alternate" attends college. Thus the job is kept continuously filled, and each student is enabled to spend approximately half of his time in college. The length of the period of alternation varies in different institutions, as does the total amount of work experience required and the point in the student's curriculum at which it starts. While the "two-man team" principle is generally observed in co-operative programs, it is not universally followed and is not a fundamental principle of the co-operative system. In some institutions the co-operative program is so arranged that all co-op students go to work at one time, and all return to college at one time. Certain advantages are claimed for this type of program, but the majority of institutions still use the "two-man team" arrangement. Even in the institutions which normally follow the practice of "pairing" students it is sometimes necessary or desirable in individual situations to provide only one co-op student for a given job, which can be handled in such a way as to permit him to return to college for the regular class periods. The essential feature is not the "pairing" of the students, particularly, but the alternation between periods of employment and periods of class attendance.

Counseling Services: High Priority

Over the years professional counselors in the field of education have come to recognize the unique advantages in the co-op education system which accrue to the three parties concerned—the institution, the employer, and the student-trainee. There is ample testimony from all three parties, in the literature of co-operative education, in regard to the values and advantages which have been derived from participation in this kind of program. Indeed, some of the basic documents published by the U. S. Office of Education and the Co-operative Education Division of the Americal Society for Engineering Educa-

tion present this phase of the subject very well and should be of considerable interest to school counselors.

Of particular significance, however, is the *counseling* aspect of the the co-op program of the Bureau of Ships. It is particularly noteworthy because of the scope of the counseling function and the distribution of its emphasis at points where it is most crucial. The counseling function, which is shared by the professional engineers and scientists as "line" officials and the members of the Personnel Division or Industrial Relations Department as the "staff" officials, takes shape in the following ways in the program: (1) conferring with high school principals, school counselors, and teachers of mathematics and science; (2) orienting high school students, through addresses at high school assemblies and participation in career clinics and similar activities, to the classical and the new areas of engineering and scientific specializations as they are utilized in research and development laboratories and naval shipyards; (3) advising parents and interested youth, both in person-to-person conferences and in written correspondence supplemented by well-prepared brochures, of the opportunities available for eligible candidates and of the special features of the program; (4) advising high school students in their junior year of the selection of courses and special readings and home study which will better equip them for eventual college studies in engineering and science and for competency in their jobs; (5) sound placement of the student-trainee in his first job, and orientation to the new job as he undertakes his first summer work period prior to entering the college in September, and evaluation of his progress and adjustment during this initial work period; (6) co-ordination with the evaluation reports of the co-op program Coordinator at the college through direct visits or through periodic correspondence, in order to integrate the two evaluations—the one relative to his academic progress and the other relative to his on-the-job progress; (7) sound supervision and informal counseling (as well as the required formal Performance Rating) of the student-trainee by the supervisor of his work unit during the employment period, and clearly directed appraisal and counseling designed to improve his capacity to bridge theory and practice in furthering his professional growth—and, this is prescribed for *every* work period as the student-trainee is rotated from one engineering branch to another or advances at successive levels within the same branch; and, (8) counseling, at the time of graduation, on career opportunities in his field of specialization and the availability of certain challenging work assignments and projects to tap his abilities at the professional engineer or scientist grade.

In addition, there is full provision for personal counseling as may be needed by the student-trainee in regard to matters of health, per-

sonal finances, insurance, hospitalization, home problems, travel, housing, recreation, and other matters. Here, the naval activity makes available the services of its Employee Relations Division, Employee Services Division, Safety Division, Medical Department, and other units. Above all, however, the focus of counseling is *educational counseling*—that is, an integrated effort of the employeer and the institution to assist the student-trainee in achieving the best kind of progression of academic and experience attainment and personal maturity and growth which will speed him on the way toward his professional career objectives. Closely allied will be such counsel as to encourage the student-trainee's participation in professional activities such as the preparation of technical articles, patents, membership in technical societies (especially those which have student chapters in the various colleges), attendance at meetings and forums, and related activities which are part of the life of a professional engineer or scientist. To the extent that he can also gain some appreciation of the problems of management, human relations on industry, employee teamwork and worker morale, and the significance of the wise use of resources in a job setting—this, too, will constitute part of his counseling and self-education.

Look to the Future

The 550 student-trainees selected in this program are engaged in engineering and scientific work assignments in various units of the naval activites: Design, Division, Electronics Office, Production Department, Public Works Department, and other units. They are in the company of competent professional practitioners in civil, chemical, electronic mechanical, marine, electrical, air-conditioning and ventilating, and other branches of engineering, naval architecture, and physics, mathematics, chemistry, and electronic science. They are pursuing their college studies, in alternating academic quarterly or semester periods, at accredited colleges. Now, we are to turn to the important *internal* phase of the program. The goals are well set: the best kind of supervisory climate; individual guidance; coordination of the appraisals of the college and of the employer; constant monitoring to assure that there is sound integration of the college studies and the work experience in the student-trainee's total program; effective utilization of the abilities and knowledge of the student-trainees in productive and meaningful work assignments. These are the essentials. Through the continuous and sustained counseling function within this co-operative education program of the Bureau of Ships it is believed that we shall go a long way to assist these young people to emerge as mature professional engineers and scientists, as well as to make a noteworthy contribution to the solution of the nation's persistent manpower problem.

WHAT'S WRONG WITH MATHEMATICS

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Any mathematics teacher who is attempting to keep abreast of current developments in the field by reading professional periodicals; attending professional conventions, summer sessions, institutes, or conferences; or similar activity cannot help but be aware of the fact that there is currently much agitation for change in our traditional offerings. Any attempt to reproduce all of the material bearing on this subject would involve a very large amount of space—probably beyond that which could be justified in any periodical or even in a book. The classroom teacher is also probably aware that although there is not universal agreement, neither are we completely at loggerheads. It may be true that certain individuals or groups are sponsoring or recommending one type of change while others seem to feel that more improvement could arise from another kind of revision. Most agree that some type of revision is needed.

Without any pretence that the material is by any means exhaustive or necessarily representative, this article will summarize some criticisms of mathematics. Deliberately and with a definite purpose there will be no attempt to give specific reference to the particular quotation. The teacher may be interested in seeing if he can identify the person or the group to which this point of view might be attributed.

One criticism which seems quite common refers to the mathematics program in general rather than to specific courses:

> Our traditional methods have delayed the teaching of much that is interesting and valuable in the secondary field.

Teachers are familiar with the criticisms that refer to the inclusion of material no longer of value:

> Obsolete and useless material is still perpetuated in abundance.

> Old material will have to be dug out and new material inserted in its place.

Perhaps closely related to this are the criticisms suggested in the following comments:

> Pupils are bewildered by a multiplicity of detail, without apparent relevance either to great ideas or to ordinary thoughts.

> Pupils have got to be made to feel that they are studying something and not merely executing intellectual minuets.

> The excessive emphasis now commonly placed on manipulation is one of the main obstacles to intelligent progress.

Some of the criticism, whether justified or not, perhaps reflects the opinion of the college and university teacher:

Something is wrong with high school mathematics as taught; that something eternally curves back to two prime factors, (a) too much "sawdust" in the content and (b) too much water in the teaching.

The college professor is now obliged, during the freshman year, to spend a large part of his time and energy in reviewing what the student is supposed to have learned in the high school.

Mathematics people in college are certainly more interested in your teaching theory than practice. You can waste a lot of time with transits, sextants, etc. Few of your class will ever have any use for them, and the engineers (prospective) will have to be taught it all again anyway. Hence the use of these instruments is merely to amuse the class. It is the "theory" that is practical.

The teacher also comes in for some criticism from the point of view of not keeping abreast with current mathematics:

Few teachers, probably, realize that they are living in a period of great mathematical development. New phases of old problems, new problems and new methods are continually demanding some new modification in mathematics or else out and out new methods in mathematical procedure.

From the point of view of constructive criticism there is apparently some realization that teachers are not unaware of some of the problems and an attempt is being made to correct some of the flaws:

We now have a high school population that is not only very different from that of thirty years ago but is also much larger.

We are just now seeking, and that too very earnestly, both reform and progress in larger than the usual measure in the teaching of secondary mathematics.

In addition to general criticisms of mathematics there are definite criticisms of specific courses. It is, of course, impossible to list criticisms of all the courses being taught. If we consider algebra as an example we find:

No subject in the high school curriculum . . . has yielded such unsatisfactory results as algebra.

The facts of algebra are worthless if not understood.

In our algebra, for example, there are many survivals of material which antedates the invention of the Calculus, and while not without considerable intrinsic interest for the algebraically minded is of merely historical importance.

If we are to improve America's algebra we must see to it that algebra finds uses in the geometry class.

The criticism is not limited to secondary school algebra:

To be frank we shall have to admit that college algebra is a conglomeration of topics.

Geometry, likewise, comes in for its share:

If we . . . propose . . . that the structure of high school geometry should as in Euclid be based upon measurement and should be used as in Euclid for the careful and sound development of the idea of continuous number . . . we can hardly expect a spontaneous welcome.

In geometry, the Euclidean development, while not inappropriate for an age

when it constituted the whole body of mathematical training and when physics, chemistry, and biology were unknown or unorganized, contains much that is non-essential in the modern development of mathematics.

The present standard course in geometry is still powerfully influenced by the tradition of Euclid, who wrote before the methods of algebra, trigonometry, analytic geometry, and the calculus were available.

In our attempts to imitate Euclid, we have committed ourselves forever to a style of argument pedantic and verbose and to an order of topics so involved with the vested interests of standard examinations that any change is a cause of panic.

There has been nothing new in geometry as it is taught in our high schools since the time of Euclid 2200 years ago.

In particular there seems to be criticism of solid geometry and several suggestions imply that this might well be combined with the material of plane geometry, possibly reducing the length of time devoted to the subject:

No subject in high school mathematics receives less constructive consideration than does solid geometry, no subject is more poorly taught nor more useless.

It should be possible to omit some of the plane geometry without weakening the course materially in order to make room for enough solid geometry that is considered worthwhile.

Probably no question is receiving more attention today than that of the reorganization of plane and solid geometry.

It is possible and desirable to introduce the more elementary ideas of solid geometry in connection with related ideas in plane geometry.

Since most pupils are now getting no solid geometry, a one year course in demonstrative geometry to include both plane and solid geometry will tend to increase rather than decrease the logic value, preparatory value, the practical value, as well as the cultural value of the subject.

Some feel that blame should be placed upon the colleges for the inability to make revisions which might be desirable:

Senior high schools do not dare attempt revision as long as colleges insist for college entrance requirements on one year of plane and a half year of solid geometry.

Although other quotations might be added a single item will indicate that the criticism is not limited to the field of plane and solid geometry as taught in the high schools:

I gravely doubt whether the ordinary college man, not intending to specialize in mathematics or engineering, will profit either now or later from a treatment of the normal form of the straight line equation.

One revision quite commonly advocated suggests that some of the difficulties might be avoided by the use of unified courses. Several quotations relate to this point of view:

The traditional mathematical curriculum of a standard high school is usually: one year of algebra, one year of geometry, half a year or a year of advanced algebra followed by solid geometry or plane trigonometry or both. Plainly this

course is a succession of partial courses or branches taken throughout the high school period.

Wherever the conditions permit we should rearrange our mathematics so that we shall not have courses in algebra, in geometry, or in trigonometry as such, but a definitely arranged and psychologically ordered course in mathematics.

Does it not seem rather a matter of tradition only that we have kept the algebra, the geometry, and the trigonometry in strictly parallel lines of treatment?

But, even this solution is not completely satisfactory. A single quotation is used to illustrate this viewpoint:

The classical separate courses fail to show the interdependence of these courses, an understanding of which is necessary for adequate comprehension of each. But at the same time . . . the newer "unified" courses have a tendency to be superficial and . . . fail to give that continued attention to each of the well defined separate elements of the subject, which is also necessary for adequate comprehension.

Other individuals suggest that we add specific courses. This is particularly true at the secondary school level. Some would suggest that we might in the senior year offer analytic geometry:

An elementary analytic geometry is no more difficult than an elementary synthetic geometry.

. . . analytic geometry is an ideal study for the last half of the year before entering college.

Others (although not necessarily arguing against analytic geometry) feel that calculus can well be introduced at the secondary school level:

Because of the important position occupied by calculus in the mathematics structure, twelfth year pupils who are interested in mathematics should be given the opportunity to become acquainted with the subject.

It seems desirable to place the calculus in the curriculum of our senior high schools. Time could be found for such a course if much irrelevant material offered in our present courses in mathematics were discarded.

What advantage has the calculus over other branches of mathematics which may be taken during the senior year of the high school course? Let us consider other possibilities. There is analytic geometry but it has no applications; higher algebra including permutations and combinations, theory of equations and theory of determinants does not lead anywhere.

It is both surprising and gratifying to find the extent to which the graph work of analytic geometry necessary for a course in high school calculus has already been developed by the recent text books on secondary mathematics. An examination of these books shows that not only are straight lines and parabolas plotted but a number of them include cubics also.

Another approach often recommended would not necessarily change existing course offerings, at least by title, but would suggest deletions, additions, and the like. Several varied suggestions appear in the following quotations. These are by no means exhaustive:

. . . it is better to substitute the simpler parts of higher mathematics for the more difficult parts of arithmetic, algebra, and plane and solid geometry.

. . . may I suggest a course in the appreciation of mathematics? . . . the history of our number system is something that every educated person should know.

We may be overlooking . . . the inner relations of mathematical truths to each other.

Graphical methods have been suggested:

At present there is practically no excuse for the teacher to omit graphs since the student should receive this training whether he goes to college or not.

. . . more attention to certain graphical methods, especially . . . in connection with statistical data and simple forms of functions. Some study of averages such as arithmetical mean and weighted mean are easily within the grasp of high school pupils.

Some would suggest concept of vectors, others non-Euclidean geometry or modern geometry:

The idea of a vector is so common in the study of science and the vector method so easy and effectual in application that students in preparatory schools should acquire an understanding of the subject.

The "Why" of non-Euclidean geometry is of extreme importance for the clarification of our ideas on what constitutes mathematics.

The experiment of introducing modern geometry into the secondary schools has been tried with varying success.

Synthetic projective geometry might contain inherent elements which would make it worthy of consideration as a part of the secondary school course in geometry.

Imaginary or complex numbers are offered as suitable additions:

It is more than necessary for us to teach the freshman student the elementary properties of imaginaries.

[This particular comment is relating to freshmen high school students, not freshmen college students].

It is high time we had some change in the type of exercises in the algebra of complex numbers for the immediate as well as the future interest of the student. The student naturally wants to use the imaginaries in the proofs of the mathematics he already knows, in the demonstrations of elementary plane geometry, for instance, as well as in the proofs of the plane analytic geometry in the next semester. These advantages we have denied him.

There is no reason why the student should not be encouraged to solve some of his problems by the method of the complex variable in his course on analytical conic sections as well as by the usual Cartesian coordinates.

Some writers, although less specific, still suggest additions or changes:

Mathematics is fast becoming essential to the study of economics and the calculations of modern business.

The student's work in the [freshman] course should be supplemented by brief lectures on the significance of important ideas and processes, and of mathematical analysis as a mode of thought, historical matters, the nature of mathematics as a logical system, its universality and some of its philosophical implications, the logical side of algebra, the parallel postulate and possibly some references to relativity.

The primary purpose of the teaching of mathematics should be to develop those powers of understanding and analyzing relations of quantity and of space which are necessary to a better appreciation of the progress of civilization and a better understanding of life and the universe about us, and to develop those habits of thinking which will make these powers effective in the life of the individual.

A great many colleges and universities fail to provide courses at the proper time for students who are ready and eager to go on and often loss of time and gaps in instruction appear.

Elementary applied mathematics courses which frequently are too unmathematical to be of great value are given in the departments of colleges that have need for them because it is felt that the theoretical treatment as given in the regular courses of the mathematics department is unnecessarily thorough. This procedure is very apt to lead directly to the inappropriate use of mathematics.

Among the criticisms, most of which seem definitely constructive, there are comments which definitely indicate evidence of improvement:

After twenty years of persistent effort on the part of reformers, we can see a marked change in aim, method, and content of mathematical curricula.

A new type of mathematics which is better adapted ultimately to our recent developments will take the place of the traditional courses in the secondary schools.

Probably one comment relative to the lack of uniformity in our opinions is as pertinent as any:

The strongest evidence that much detailed and exacting work remains to be done in organizing a sound curriculum in mathematics is the fact that there is no general agreement concerning the details of the reorganized courses now in existence.

Certainly the preceding compilation of comments, suggestions, and criticisms is by no means completely representative nor is it exhaustive. It was selected by the author with a definite purpose in mind. It may be that if the reader has persevered this far he feels that he can identify some of the groups or individuals who are currently thinking along the lines of mathematical reform. If this be the case, he may be in for a rude shock.

All of the quotations are selected from professional journals published by mathematics or scientific groups in the period 1917–1932. *Not a single statement is written later than 1932—twenty-five years ago.* If requested, the author of this article will furnish the exact reference.

Is there any lesson in this for us? Possibly a comment might be that perhaps we should talk less and do more. Individuals who have seen the manuscript were positive that they could identify some of the quotations as less than two years old. This does not imply that the habit of criticism is wrong but if, after twenty-five years, almost identical criticisms can be made one wonders if we are making as rapid progress toward revision and improvement as might be desired.

TEACHING HEALTH EDUCATION IN COLLEGES

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At any level, health instruction together with health service and healthful school living make up what we call health education. This paper will deal primarily with the first aspect. We firmly believe that health will always merit a leading place among the various cardinal aims of education. But, when we take stock of the accomplishments and effectiveness of our various methods of presentation of this discipline, we find that there is room for much improvement.

For the average person, the possession of a reasonable state of good health is absolutely fundamental to success in any field. Granted that health is tremendously influenced by heredity and economic status, we believe that the possession of pertinent information and intelligent attitudes also plays a major role. In the last three wars, physical examination of our young men under the Selective Service and Training Act resulted in rejections of from thirty to thirty-five per cent. Although the primary cause was mental deficiency, many of the other rejections were due to conditions that were both preventable and correctible, had the personnel concerned been so informed and so inclined. The health of our youth has been cause for concern by President Eisenhower, and several White House conferences pertaining thereto have been held.

While the average span of life is now about seventy years, the gains have been due more to reduction in deaths during infancy and early childhood before freedom of choice has developed, rather than to reduction from causes due to accidents and chronic diseases. The control of the latter lies, of course, to a considerable extent in the hands of the person concerned. Most of our health needs are constant, they are neither new nor critical. But as with religion, revivals, new looks and re-evaluations are considered desirable from time to time for the maintenance of those health principles deemed to be good. What then are some of the problems of instruction in health education?

In the first place, our students need to be convinced that health education is important. In a college class, one generally finds a group of young animals so brimming with vitality that the chance of any future loss of the same seems to be the most remote of possibilities. Disinterest may exist if, through any particular misfortune, the physical health of the teacher compares unfavorably with that of the class. Many health teachers are such poor examples of what they are trying to teach that their efforts are nullified by the example which

they set. The husky layman, however, does not necessarily lose faith in the frail physician whom he may, and probably will, outlive. The health teacher is not expected to lead and outdo the class in calisthenics and pole vaulting. Nevertheless the students must be convinced that there is no substitute for information obtained in the classroom.

The value of health knowledge must be sold to the class without excess dramatics and fanfare. Approaches which are largely emotional in nature do not impress for long. However, one can seize on timely problems to establish rapport in selling the subject to the class. The writer's class of some sixty students acquired immediate interest as well as concern when told at the first meeting in September that Asiatic influenza was on the way and that one in ten would probably become a patient. This prediction was later substantiated.

A second point of special importance in successful health instruction deals with the preparation of the teacher. In many secondary schools, this assignment is handed to a physical-education instructor in the belief that exercise is a core activity in health attainment. If the instructor's mental development has kept pace with the physical, this is often a happy selection, because a large proportion of the members of a health class will usually have definite athletic interests. Then too, if a doctor of medicine is available and has the time, he may be assigned the teaching of health. This set up may be unsatisfactory because the medical doctor, although highly trained in the therapeutic art, usually has little skill in the science of instruction and is seldom well versed in the meaning of health except as it relates to freedom from disease.

The ideal health-education teacher should be well grounded in personal and community hygiene, anatomy, physiology, biology, bacteriology, psychology, chemistry, nutrition, mental hygiene, vital statistics, teaching methods and techniques. Personal experiences gleaned from travel, athletic participation and observation, service in health organizations and in the armed forces, research work in various health fields, all are helpful and serve to vitalize the instruction. There should be enthusiasm, a sense of humor, cheerfulness, ability to get along with others and speaking skill. Although few teachers will qualify for possession of all these virtues, it is most pathetic to find a teacher assigned to health education who is lazy, uninspiring and not too bright.

A third point involves the question of what shall be taught. This of necessity involves a consideration of what needs to be accomplished, namely to establish such knowledge, habits, attitudes and ideals as will, according to Winslow,[1] help prolong life, prevent disease

[1] C. E. A. Winslow, *The Evolution and Significance of the Modern Public Health Campaign*. New Haven: Yale University Press 1933.

and promote physical and mental well being. These objectives are similar to those of all public health activity and preventive medicine. It is both helpful and interesting on the occasion of an early class meeting to collect a list from the class of such health problems as they now consider to be most important. Such inventories of health interests plus a survey of scientific health articles most often stressed in the literature was used by Byrd in selecting the subject matter for his textbook in college hygiene.

Certain major social problems do stand out prominently today, and are of vital interest to every college student. Heart disease, hypertension, cancer, mental hygiene, accidents, alcoholism, medical care, geriatrics and civil defense should properly be included in the framework of any college health course. The health aspects of marriage and the raising of families concern most of our students. Such communicable diseases as have not yet been brought under control are obviously important. The most effective teaching in college is done without display of bias, prejudice, or moralizing. The subject of alcohol and venereal disease should not terminate in anti-sin propaganda in the classroom. The objective approach should be used. Single-track approaches to the subject of health should be avoided. Many organized health groups have ridden one horse for so long that they have lost sight of the fact that in this complex society in which we live, there are many important health problems.

The fourth and last point has to do with methods of instruction. The lecture method seems to work best for most college teachers with large classes. However, a certain amount of class participation is desirable lest the stimulus for preparation be removed and a feeling develop that the instructor will do all the work. The instructor's role in a class where a text is used is not so much to explain the meaning of the subject-matter read, but rather to amplify, illustrate and vitalize.

Occasional questions bearing on such matters as the significance of health facts are useful. Students may be asked to review and report on selected health books and magazine articles. They may also present material gleaned from observation and experience. Our college students today have been all over the world through travel on their own or with the armed forces and have much to relate.

Motion pictures may be used for special illustration or where variety is desired. There are a great many available in the health field today, but a considerable number are too elementary or too popular to warrant extensive use. For reviews, the writer sometimes places a number of selected questions in a box, has the students step to the front of the class, draw out a question at random and attempt to answer the same.

A health class will have more respect for a course and, incidentally,

will learn a great deal more if the latter is reasonably difficult and requires some work of the students. A required notebook, neatly typed, may work well in classes not using a text. Examinations should be given as often as in any other class. These tend to keep the students on the alert and to provide a fairer method of evaluation.

In conclusion, one should reiterate that the need for good health teaching in American colleges is constant and challenging. But, at the same time, it is productive of enjoyable and utilitarian experiences for both teacher and student.

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NEW GROUP WILL OPERATE NATIONAL OBSERVATORY

This nation's first National Astronomical Observatory, open to all qualified astronomers, will be built in Arizona with a grant from the National Science Foundation.

It will be managed by a new group of seven universities, organized as the Association of Universities for Research in Astronomy, Inc., or AURA, Inc.

A contract for the construction, operation and maintenance of the National Astronomical Observatory was signed by Dr. Alan T. Waterman, director, on behalf of the National Science Foundation, and by Dr. Robert R. McMath, president, on behalf of AURA, Inc.

California, Chicago, Harvard, Indiana, Michigan, Ohio State and Wisconsin are the seven universities now forming AURA, Inc. These particular universities joined together as a management group for the new observatory because they have had experience operating large observatories and because they have strong programs of research and graduate instruction in astronomy.

As the project develops, other universities and individuals are expected to join AURA, Inc., an Arizona corporation with headquarters in Phoenix.

The National Astronomical Observatory will include a 36-inch telescope and an 80-inch telescope, when completed. Its support by the National Science Foundation resulted from a five-year study by American astronomers on needs in their field.

The Foundation's appropriation for fiscal year 1958, which started July 1, includes $3,100,000 for construction of the optical observatory on a site to be selected after extensive tests. Approximately $800,000 has been awarded to the University of Michigan for site studies.

Three Arizona locations are now being tested for seeing conditions: Kitt Peak (6,875 feet), the Hualapai Mountains (7,350 feet), and Mormon Mountain (8,440 feet). Two other Arizona sites and one in California were found unsuitable for major astronomical installations.

MIND, MATHEMATICS AND MACHINES*

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Your choice of a theme for your annual convention has been an excellent one. The events of the past few weeks have more than justified the need for expanding horizons in the teaching of science and mathematics. In connection with your theme, I am going to talk about three subjects today. They are the mind, mathematics and machines.

Mathematics is the subject that you know most about. I probably know the subject of machines better than the other two. Finally, I want to talk about the mind, which is by far the most important of the three topics.

First let me state that machines are made by man and for the use of man from concepts that have been accumulating for centuries. At the present time, the rate of development of machine capabilities is accelerating.

If you want to prove this to yourself and have a little fun, you might try a procedure which I use as part of a lecture on Science and Technology. Make a list of all of the motor-driven devices or appliances that you have in your home. This would include such things as the vacuum cleaner, electric fan, washing machine, electric clocks and so on. You will probably find that you have somewhere in the neighborhood of 15 to 20 such motor-driven devices.

Then in front of each item on that list, put a check to indicate whether you had one in your home 20 or 25 years ago when you were growing up. You will probably find about one-fourth of those items were available then, so that the number has increased by 300% in the past 20 years, or one generation. Those you have are far better devices, and cost a smaller percent of a person's income than they did 20 years ago.

Then make another list. This time list the devices which have automatic controls on them. For instance, this would include the furnace with its automatic temperature and time controls. It would include the electric stove, with the ability to pre-set the turning on and off times; the automatic toaster, waffle iron and similar appliances in the kitchen. The clock radio in your home comes under this classification. Some of you may have radio controlled garage doors, or an automatic choke device in your automobile or automatic controls on a television set or the automatic cycling control on a washing machine. Again, if in front of each of these listed items you will make a

* Paper presented at the annual luncheon meeting of the Central Association of Science and Mathematics Teachers, Saturday, November 30, 1957 at the Congress Hotel, Chicago, Illinois.

mark to indicate those which you had 20 years ago, I believe you will find that the number of automatic devices and automatic controls has greatly increased in this period. Do I need to remind you that none of these devices could have been created without the cooperation of mathematics and science?

These lists are indications of our rapidly increasing technology. Let us remember that machines are things, not people. No one can say whether these things will be good or bad for us. Things aren't good or bad. Their use by people may be good or bad. We know that some people will be bad and use machines and other things in harmful ways. However, we cannot hold back all the exciting future because of a few people.

Now I want to concentrate on a very particular kind of machines—electronic data processing machines. They are sometimes called computing machines and sometimes very erroneously called, "giant brains." Right from the very beginning let me clear up one misconception. I believe that these machines do not and cannot think. Having stated what the machines cannot do, now let me take a positive look at what they can do.

Electronic computing machines are based on the number systems with which we are familiar. They usually use the decimal system. Sometimes they use the binary, or other number systems. I believe it would be extremely difficult to build a computing machine which would work in the Roman Numeral system. Somewhat facetiously, I might suggest that the decline and fall of the Roman Empire was due to the fact that when it got large, its number system was inadequate to hold it together.

One of the first mechanical contributions to our computing machines was made by Pascal in the 1600's, when he built an adding machine which incorporated the mechanical carry of one from a column to the next column to the left. The first real concept of the computing machine was made by a professor of mathematics in England, named Babbage. Something over 100 years ago, he wrote the concepts of two computing machines. Unfortunately, in those days, the manufacturing technology was not able to produce the machines which he envisioned. Around 1900, a small part of a machine was built from his plans. It worked out satisfactorily.

The first really automatic digital computing machine was built in 1944. This was called the Automatic Sequence Controlled Calculator and was built by IBM from designs drawn up by IBM and Harvard University, where it is still in use today. This machine was a mechanical machine rather than an electronic machine. The first electronic computing machine which IBM built was running early in 1948.

In the four-year time difference, the computing machine had in-

creased its *storage capacity* by more than *100 times* and likewise had increased its *addition speed* by more than *100 times*. In 1952, we started a production line of electronic data processing machines—the previous two machines were *one-of-a-kind machines*. The 1952 machine, our type 701, was again larger in storage capacity by 20 times and was more than 100 times faster than the 1948 machine.

Just two years later, in 1954, the IBM Corporation produced another one-of-a-kind machine, the NORC, which is the name for the Naval Ordnance Research Calculator. The storage capacity for the machine had increased by some six times, and the computing speed had increased by a factor of four.

I mention these figures just to give you some idea of how rapidly computing machines have evolved and how quickly their power has increased. We are currently building the planning machines for the next few years which will be 100 or more times more powerful and faster than the machines which are now being produced. The cost of these large machines is about two or more megabucks. A megabuck, as you probably know, is a million dollars.

So much for the rapid evolution of machines. Now let me talk for a few minutes about what they do and how they do it. Electronic data processing machines all have five fundamental sections, each of which is self-explanatory. They are: input, output, storage, arithmetic (processing), and control. Basically, these machines can do only two things. They can *add* and they can *compare*.

Machines can do subtraction by complement addition, they can do multiplication by repeated addition, they can do division by repeated subtraction which is a form of addition. Therefore I claim that these machines can only do addition.

Machines can compare the size of two numbers and tell whether one number is greater than, equal to, or less than another number. This ability to compare two numbers is vital to the *control function* of the machine. It allows the machine to do sequences of thousands or more calculations as fast electronic speeds, without human intervention. This *ability to compare* leads people to believe that the machine can *think*. The machine can compare two numbers on the basis of a pre-determined set of rules. If the second number is larger, it will go into a different sequence from the one used if the second number is smaller than the first. This comparison ability, however, is far from the real ability to think.

I have stated that these machines, internally, can only do simple arithmetic. How can they possibly solve complicated problems in calculus and engineering? People must interpret the problems into sequences of arithmetic operations. The large computing machines can solve complicated problems in higher mathematics in exactly the

same way that you can solve the same problems using a desk calculator. You must break the problem down into a sequence of steps of simple arithmetic. Problems in differential calculus are solved by transforming the procedures into differences rather than differentials. Problems in integral calculus can be solved after integrals are changed into summations. I want to emphasize the importance of people. Machines can only solve problems if people can set up the procedure.

Sooner or later a question is going to come up concerning mistakes. Can a machine make a mistkae? How can a machine check what it is doing? The answer to the first question is that machines can make mistakes, if they are not functioning correctly. Everyone by now knows that a piece of mechanical or electronic equipment sometimes is not functioning correctly. How do people know that the machine is doing something correctly and what do they do if it is making mistakes?

If you stop to consider the error possibilites of a desk calculator and one of the large computing machines, you will find that the latter are tremendously free of errors. If you are operating a desk calculator and it makes one mistake in a million computations, this would be two errors in a year. However, in an electronic computing machine, the machine will make over a million computations in one minute. It should be obvious to everyone that a machine which makes a mistake once a minute could not possibly be of any use. Electronic data processing machines these days can run trouble free for many hours which corresponds to billions of computations without an error. This is a marvelous record of reliability. In most cases, errors are traced to the people, not to the machines.

There are many problems which have built-in checks. For example, in certain trigonometry problems, if you take the sum of the squares of two numbers, it must equal the square of a third number. A machine can make this computation and if it finds the two sums are equal, go on to the next step. If it finds the sums are not equal, it can stop or it can be made to repeat the sequence a pre-determined number of times and then stop. Whenever possible, we let the machine do the computing and checking—it is faster and more accurate and reliable than people.

Another procedure is to have the machine repeat a problem, using a slightly different procedure or a different part of the machine. Then compare the second answer with the first. If the two answers are the same, it is assumed that both are right and the machine goes on. Another way, of course, is to have a computing machine which is really two identical computing machines and have the two compare answers as they go along. In either case, a person is going to have to pay for time for the second calculation or for the physical hardware for the second calculation.

It has been said that machines have some human qualities. It takes a fair amount of imagination to say this. However, it has been said also that theoretically it is possible for machines to reproduce themselves—but fortunately they don't know it! Today, we have computing machines that can test many of their own circuits and report a malfunctioning part. This is perhaps like a person's diagnosing his own pains for the doctor and there is a certain amount of danger in doing this.

Under certain conditions, it is possible that present-day machines could be modified so that they could repair themselves by replacing or switching to duplicate parts. Imagine a machine, made of two identical units. All of a sudden, the two do not agree on a result. The "bad" unit thinks the "good" unit has made an error and starts to fix it! Perhaps there should be three units and the vote should always be at least two-to-one before any action is taken. Here we should really see a mechanized democracy. This is humorous, but it also opens great areas for the future.

What kind of problems do these machines help us solve? In the accounting and business field, they do data processing such as payroll computations, accounting, billing for utilities and insurance companies, process inventory records and so on. In the engineering and scientific field, the machines can compute design shapes for specific purposes such as cams for control devices, airplane wing cross sections for given flight characteristics and structural shapes for strength of buildings. They can compute the vibration characteristics of structures. They can also do a host of different kinds of statistical procedures and solve equations of many different kinds. A very interesting class of applications is that of simulation. This involves setting up a mathematical model and having the computer give the results of putting some input data into the model and getting some output from that model. Let me give a few examples.

One of our good customers puts airplane engine characteristics into machineable form in a deck of punched cards. This customer gives this deck of cards to airplane manufacturers. These manufacturers have the characteristics of the air frame also in machineable form. They put the two decks of cards into one of our large computing machines and specify what the airplane is to do, such as take off under certain take-off conditions; climb; fly at a certain speed in a certain direction with specified weather conditions. The computing machine can then give the results of time, distance, velocity, fuel consumption and other things. There should be no magic or mystery about such a process. This is nothing more or less than what a person could do, in fact what each one of you could do, if you were given all of the necessary information and the computation procedures. The only difference is that the computing machine will do this about a million times

faster than a person can do the same computations on a desk calculator.

Let me give another specific example. One company wanted to know the minimum runway length needed for an airplane to take off and clear a one-hundred foot obstacle at the end of the runway. There are two ways to solve this problem. One is to take an airplane, a runway and a one-hundred foot obstacle and start the plane at the end of the runway and see if it can clear the obstacle. If it does, you then reduce the length of the runway by a few hundred feet and try the experiment again. At some runway length, the plane will just clear the obstacle. Airplane pilots, incidentally, would take a very dim view of this kind of experiment. The same results can be achieved by flying the airplane inside a computing machine, but the computing machine computes the flight characteristics and take-off characteristics and gives the altitude and distance from the point of take-off. This is a considerably safer and cheaper kind of experiment.

What are some of the other simulation areas? A computing machine is now used to simulate the behavior of an oil refinery. A set of mathematical relations have been prepared for computing machines so that when the characteristics of the input crude oils are given, the computing machine can produce in just a few minutes the data of the kind and volume of output chemicals the refinery can produce. This is very useful to the petroleum company in determining whether their crude oils will give them the products they need.

In quite a different area, we are now simulating the weather over The United States. The Weather Bureau in Washington every day receives hundreds of weather readings from all parts of the United States. These readings are added to a mathematical model in one of our big computing machines and in a relatively few hours, the weather prediction for the next 24 hours is made. This whole project is still in its early stages, so we are not always able to predict a particular rain shower at a particular time or at a particular place. However, general conditions of barometric pressure, wind velocity, and humidity are computed. As the study of this problem goes on, we shall be able to get better and better weather predictions and also longer range weather predictions. It is hoped that some day, we shall be able to predict the weather all the way around this world of ours.

In another case, a railroad train can be simulated in a computing machine. The factors of the weight of the train, the track slope characteristics and the pulling power of the locomotive are all put together and the computing machine can print out a record of the time, distance, velocity and acceleration of the particular train combination.

We now use computing machines to simulate other computing machines. When we are designing a new computing machine, we make

one of our present computing machines represent, in terms of equations, the characteristics of the new machine that we are interested in studying. We can then determine the behavior of this new combination and tell whether it is satisfactory or whether certain characteristics need to be changed before we have to build any part of the new computer. These, and hundreds of other applications are being put on computing machines every day. They are successful because mathematical models can be formulated which have the same operating characteristics as the physical things which they simulate.

A data processing machine can be used at one time to compute the path of a ballistic missile or satellite and just a few minutes later, it can be translating sentences from one language to another.

This versatility is possible because the physical machine does not need to be changed from one problem to the next. Only the instructions need to be changed and they are in the form of a sequence of numbers which can be read into the machine quickly and stored in the storage section awaiting interpretation for control of the computer's data processing section.

There is a new area of simulation which has just recently been developed. It started about a year and one-half ago, when an American Management Association research team set up a mathematical model of a fictitious economy within which five companies could compete for a share of the market. They now use this model for training company executives by giving them experience in making decisions.

A group of three or four people form the executive team representing each company. They must make decisions on how to allocate their available cash in terms of production, research and development, marketing efforts and so on. The decisions of the five companies are then put into one of our medium-sized computers. The machine, in a few seconds, evaluates the relative position of the five companies in the competitive economy. A new quarterly financial statement is printed for each company and the men make another round of decisions. I have just participated in a session on decision-making held by AMA and I can assure you that it provides a very realistic experience.

In this manner, executives can get decision-making experience in one day which would take them several years to accumulate in real life. Now, granted that these decisions are not exactly the same as they would be in real life, they nevertheless give men the ability to make decisions similar to some of those which may come up in real business. They are given the opportunity to make some poor decisions, and see the effects of their decisions in a much less costly form than if they did this in real business. There is a tremendous future in

this model-making and simulation area and that is why I mention it at this time as one of the new horizons for people who are interested in mathematics and science.

The technique of model-making will allow business areas such as economics, accounting, administration, etc., to have laboratory experience which *has never been available* before. We have laboratories in the physical sciences and engineering but there has never been a real laboratory available to people in the social sciences and in the economics field. The model-making is going to be quite difficult in those fields. Before you jump to the conclusion that we can make a mathematical model of a person and put it in the machine and have the sociologists study it, let me reassure you that we have no intention of doing any such thing. On the other hand, we can sometimes simulate the mass behavior of millions of people on a statistical basis. This is done every day and it doesn't necessarily take a very large computer to evaluate some of the things that happen.

Why do I mention simulation and stress it so much? It means a tremendous opportunity for people with a mathematical background to work in many other fields. It is not only an opportunity, but it is now getting to be a demand. In fact, for the first time in history that I know of, there is now a growing recognition and demand for mathematicians by the thousands. The current publicity in newspapers, on the radio, in journals and books being published, shows a big upsurge of interest in science and mathematics. I think that teachers of mathematics and science are going to begin to receive some of the recognition which has been due them for a very long time. In connection with this sudden up-turn in the demand for mathematics, we will of course need many more theoretical mathematicians and new methods of solving problems. On the other hand, we will also need many people who can work in the field of applied mathematics, applying the already developed techniques to the other fields of science which most surely need the mathematics.

I suggest to the scientists that it would behoove them to become acquainted with more mathematicians so that they can get mathematical assistance for their specific problems. I also suggest to the mathematicians that they become personally acquainted with more scientists so that they can get more and better ideas of the use of their mathematics.

In particular, I suggest that mathematicians make an extra effort to help get their language of mathematics understood by the laymen. This is a communication problem because the language of mathematics and its very concise notation form is quite different from the language of the man on the street. I think both sides will have to give a little bit. The mathematician will have to have a little more patience

in explaining his language of mathematics and the man on the street likewise will have to have a little more patience in trying to understand what the mathematician is saying.

Now I would like to talk for a few minutes about the human mind, or brain, and its education. The brain occupies a few cubic inches of space and weighs about three pounds. It is one of the biggest puzzles of modern science. Only in the past 25 years have we begun to increase our knowledge of its function by great advances in neurophysiological research, electronics, instrumentation and radioactive tracer techniques. This small mass, by its actions, has enabled man to transform the world to its present standard of living and also discovered the means to destroy our civilization.

We have tried to build models of the brain to study its behavior. It is estimated that the brain has some 10 billion neuron connections. One person estimated that a computing machine to equal the brain would occupy a building the size of the Empire State Building in New York, require the power generated by Niagara Falls to run it and all of that water supply to keep it cool. Think of the machinery required to replace just the brains in this room! Machines won't replace people for thinking for a long time!

On such a comparison, I believe that you will agree that the human mind is a tremendously capable thing, and that we usually do not give it credit for its ability. I have heard several estimates that we normally do not use more than five percent of our mental ability. Think how we could effect things if we were to double that use, still using only ten percent of our mental abilities.

From a memory standpoint, a small computer can store or remember many things, but it cannot associate them in the ways that the human mind can. For example, all of you can remember the day you graduated from high school, or the day you graduated from college, or the day you were married. You can remember many things about that particular day, the weather, what you wore, the guests and friends who were present and so on. That is just one small segment of the tremendous storage power that you as a human computing machine have. Scientists are continuing to study the human mind to find out more and more about it.

What about the education of the human mind? We have suddenly been jolted out of our dream world of superiority. The newspapers are suddenly full of stories about the shortage of scientists and engineers. If we will just turn out more of them than Russia does, we will again be safe—*or so many people believe.*

What does it take to bring about the realization that it is not merely more scientific education that we need, *but more education?* The students in schools today—as well as their parents—need greater

incentive and direction toward becoming educated men and women.

What can teachers do to provide this incentive and direction?

From a teaching viewpoint, I suggest that every teacher of mathematics should bring in the application of mathematics from time to time, to some of the scientific fields and likewise, the teachers of science bring in the importance of mathematics. Only by this kind of cooperation, can we achieve the result that we need in this country in the next few years. Would it be possible for each one to bring in at least once a week in just a few minutes something a little out of the ordinary in terms of interest? For instance, have any of the math teachers considered working out with an engineer or a physicist the equations for the behavior of one of these artificial moons which is now circling the earth? Certainly at the high school algebra level, the simplified equations should be possible to explain to the youngsters and let them feel they know a little bit more about what is going on. How about a current events period for math and science?

Dr. Urey commented on the anti-intellectual attitude in this country. This has been brought on to a large degree by the intellectuals acting superior and aloof instead of being friendly and trying to help in being understood. I urge all of you to make some friends with other people who don't have the same interests and education that you have—you can help educate them and they can help educate you. Believe me, it will help both parties.

I understand that some teachers have stated that they will not allow TV techniques to be used in connection with teaching. If I understand this blanket ban statement correctly, it is a ridiculous action. It is as though teachers banned all books and said education had to be absorbed by hearing it from them, instead of reading.

The teaching profession must use every technique and idea possible, wherever applicable. Perhaps this new TV idea of flashing short messages on a TV set for impressing ideas on the subconscious mind could be used with slogans such as be smart, get educated, do homework, or others.

In conclusion, may I repeat the few points I have made. You are to be congratulated on your devotion to your profession and the good work you are doing. You must do even better in the future. Machines have been developed to do wonderful things. They are only *things* to be used *by people* for the *good of people*. None of our civilization can exist without mathematics. More should be taught in an interesting, inspirational manner.

We have great physical assets in this country. We must develop our mental assets which today are not well used. This is not only a challenge—it is now a question of survival. We can't say let industry, or government, or any part of our population do this work. It is up to all people under the guidance of the teachers.

In the past few decades, our horizons have been expanding physically from city to nation to world. In the past month, science has suddenly expanded our horizon to the limitless regions of space. We must match the physically expanding horizons with equally expanding horizons in the teaching of science and mathematics.

I am sure you will.

Thank you.

SURVEY OF SCIENCE STUDENTS

America's future crop of scientists and mathematicians may be forecast more accurately as the result of a nationwide survey—the first of its kind—now being conducted by the U. S. Office of Education.

About 1,100 colleges and universities have been invited to participate in a tally of college juniors majoring in science and mathematics. More than 600 of these institutions have assisted in pretesting the survey questionnaire, which has been developed during the past year.

Lawrence G. Derthick, U. S. Commissioner of Education, said in announcing the study, "It will give us a two-year lead in our knowledge of the potential supply of scientists and mathematicians. Such knowledge is urgently needed by educators and others in planning the Nation's educational programs."

The questionnaire covers such physical sciences as physical science, general; astronomy, chemistry, metallurgy, meteorology, physics, geology, geophysics, oceanography, and other earth sciences and physical sciences.

The biological sciences include general biology, botany, zoology, anatomy and histology, bacteriology, biochemistry, biophysics, entomology, genetics, physiology, plant pathology, plant physiology, and other biological sciences.

All mathematical subjects and statistics, including actuarial science are covered by the questionnaire.

The survey, should help educators deal with the problem of "drop-outs" of science students—students who begin but do not complete a scientific education. It should also aid institutions in planning staff and facilities for future science and mathematics enrollments.

Being on the junior-year level, the count will provide a basis for estimates of the number of new scientists and mathematicians with bachelor degrees two years hence, and those with doctorates in five years.

Several months will be required for completion of the survey. The survey will be continued annually.

"PROJECTION RULE"

Sol Whitman's article, "The Decimal Point—Your Slave or Master?" in the December SCHOOL SCIENCE AND MATHEMATICS contains an excellent method for positioning the decimal point. I have used a similar method in teaching physics. However, if one teaches use of the slide rule, I would suggest the "Projection Rule" of H. W. Leach and George C. Beakley as demonstrated in their *Elementary Problems in Engineering*. This widely used engineering textbook is an excellent source book for high school physics and trigonometry and has been of invaluable help to me as well as to my students.

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TELEVISION USED IN THE TEACHING OF SCIENCE—AN INDIANAPOLIS JUNIOR HIGH SCHOOL EVALUATION EXPERIMENT*

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For several years, the school city of Indianapolis has been developing the use of television as a means of informing the general public about changes and developments in the public schools. Recent trends in the concept of television use implies that this medium can be employed to educate a given classroom group directly.

Consequently, in the spring of 1957, a series of television programs, designed for viewing by certain school classes was written and produced. As a part of this series, four selected junior high school groups viewed specially prepared science lessons each week for two months. The purpose of this plan was to attempt to add to the factual knowledge of the junior high pupil in the area of science and, experimentally, to determine if any difference in the knowledge of science facts could be observed between pupils who viewed the TV science lessons and those who did not. If any difference could be observed, the worth of this technique of television teaching would be demonstrated.

Evaluation of the amount of science knowledge acquired was made with a carefully constructed science facts test based directly upon the units under study at that time. The test was composed of two basic parts. The first part which dealt with electricity and magnetism had a total of 90 questions. The second part which dealt with weather and climate had 72 questions. The test items were of varying degrees of difficulty and were constructed such that no pupil was expected to get all test items correct.

The seventh and eighth grade junior high school groups who viewed the weekly science series were carefully chosen so that socio-economic, geographic, and probable learning rate factors could be assumed to be constant.

Matched seventh and eighth grade groups were chosen from the same schools to form the control or non-viewer group. In all, 224 pupils were tested at the beginning and the end of the two month period. There were 106 pupils in the experimental, viewer group and 118 pupils in the control, non-viewer group.

The average scores of each group have been used to compare the results of the respective parts of the test. Since this test has not been standardized previously, percentage increases are used to indicate the differences between the group averages.

* A paper presented at the Annual Convention of the American Association for the Advancement of Science, Indianapolis, Indiana, December 26–30, 1957.

TABLE I

RESULTS OF SCIENCE TV TEST—PERCENTAGE INCREASES OF THE EXPERIMENTAL AND CONTROL GROUP

Experimental Group (Viewed TV)			Control Group (Non-viewers)		
Part I—Electricity and Magnetism					
Pre-test	Post-test	% Increase	Pre-test	Post-test	% Increase
28	32	14%	26	27	4%
Part II—Weather and Climate					
Pre-test	Post-test	% Increase	Pre-test	Post-test	% Increase
20	24	20%	20	20	0%
Total					
Pre-test	Post-test	% Increase	Pre-test	Post-test	% Increase
48	56	17%	46	47	2%

The results show that while the group who viewed the science series dealing with electricity and magnetism achieved a gain of 14%, the control, non-viewer group gained only 4%. In the test dealing with the weather and climate, the experimental, viewer group achieved a gain of 20%, while the non-viewer group showed no gain at all. Considering the total test score, the group who viewed the science series showed an overall gain of 17%, while the non-viewer group recorded a small gain of only 2%.

From these percentage gain comparisons, one can state that those pupils who viewed the science lessons on television were able to answer 15% more science facts questions at the end of the experimental period than were the pupils who did not see the series.

The validity of the percentage increases is further enhanced by the fact that both groups made approximately the same beginning scores and that the I.Q.'s of each group were approximately the same. With two conditions in mind, one can infer that the observed percentage differences are significant. The significance of the differences between the two groups allows one to conclude that this technique of teaching, when used in conjunction with the regular curriculum, is a successful one.

As further support for the use of television for direct teaching, 94% of 1200 parents, who were questioned, gave overwhelming approval to classroom television. Of the evaluations received from teachers, 93% were completely in favor of the technique and asked that it continue.

In conclusion, the success of the experiment is quite evident. At the end of the experimental period of two months, the group who viewed the science series were able to answer a larger percentage of science facts questions than were those who did not view the series. As a technique of teaching, both parents and teachers felt it was highly desirable. Further research is now being conducted to determine the extent to which the science facts learned via the science television series have been retained after a nine month period.

FIRST GRAVITY MEASUREMENTS MADE ON SEA SURFACE FROM SUB

The first successful gravity measurements from the open ocean surface have been made from a submarine by Dr. J. Lamar Worzel of Columbia University's Lamont Geological Observatory, New York.

The measurements were part of a program to chart gravity variations throughout the world during the International Geophysical Year, which ends Dec. 31, 1958.

To make the unprecedented readings, Dr. Worzel used a sea gravimeter recently developed by Anton Graf of Munich, Germany. It was mounted on a gyro-stabilized platform installed aboard the U.S.S. *Compass Island*. Previously, gravity values for ocean areas were measured from submarines submerged to quiet depths.

The difficulty of obtaining and fitting submarines for this purpose resulted in very sparse gravity data for the 80% of the earth's surface covered by water.

Gravity measurements are used to determine the earth's shape, the true direction of its center and the density of material in the top layers. When gravity and seismic readings are used together, the thickness of the earth's crust can also be determined.

SMOG IRRITATION IS RELIEVED BY AMMONIA

The ill effects of two injurious gases possibly found in smog can be eliminated by adding either ammonia or magnesium oxide smoke to the atmosphere.

Healthy volunteers were exposed to a number of possible smog irritants including sulfur dioxide gas and sulfuric acid mist. They breathed the irritants through an oxygen-type mask or from the atmosphere inside a sealed chamber.

The sulfur dioxide gas caused watering eyes, runny noses and a high-pitched musical rale in the chest, while the sulfuric acid mist created these conditions as well as long-lasting symptoms of bronchitis, the researchers reported.

The effects of the sulfuric acid mist were counteracted by adding ammonia to the atmosphere. When it was used in the chamber along with the acid mist, it caused almost immediate relief from the smog symptoms.

The sulfur dioxide gas could also be counteracted in the same way by using either ammonia or by burning magnesium ribbon in the chamber. This destroyed the irritating properties in the atmosphere.

Experiments with sulfuric acid mist should be approached with caution, the researchers reported.

The concentration of a mist of this acid in fog is sometimes as much as three times as great as that of sulfur dioxide. It may have been one of the important toxic agents of London's "killer" fog of 1952.

During this fog, the death rate from respiratory diseases was over five times the normal rate.

PURPOSEFUL SCIENCE ACTIVITY IN THE ELEMENTARY SCHOOL

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INTRODUCTION

With all that has been written relative to the scope, content, and methods of elementary school science, the average teacher still looks for activities that have purpose, are reliable, and children can understand.

The following activity unit was written by the authors for use in their own rooms to bring purposeful science experiences to the student. The materials were written to apply to units of work dealing with ecology, conservation, and similar areas.

A major purpose of this work was to be able to give the student this material which he could read himself, interpret, and follow through on, either by himself or in committee. The teacher, in turn, could rely on the projects as being relatively foolproof if handled properly, very economical, and yet of real value in explaining the biological world.

The lasting qualities of these projects, once completed, allow them to become centers of interest in the classroom or the student's home. Most of them lend themselves to further study or basic research for the child. This type of science activity is also nicely correlated with other subject matter areas if the teacher will allow some projection of her imagination.

We must remember that science education, without purpose or meaning, is worthless. In order to carry out fundamental purposes and to achieve meaning there must be worthy activity. What follows is by no means complete, but it does exemplify the type of thing that can be successfully accomplished.

HOW CAN YOU LEARN ABOUT AND HELP NATURE?

Things you can do to learn more about nature.

I. Tree diary

Is there a tree in your yard? If there isn't, maybe there is a nice one on the way to school. Have you ever thought about picking out a tree and seeing what happens there during the year?

A tree diary is a notebook or tablet that you write in every day telling what happens to your tree. You will be surprised when you see and write about all the things that happen there.

Here are some things you will want to write about:

1. The birds that make their home in the tree.
2. Birds and other animals that visit the tree.
3. The date when the tree starts to lose its leaves in the fall. (If your tree is an evergreen, you will see that it sheds its needles at different times.)
4. The date when you first notice leaf buds in the spring.
5. The insects that live on and around your tree.
6. What the weather (wind, rain, snow, sleet, sunlight, etc.) does to your tree.
7. Any way that man changes your tree.

These are only a few of the things you can write about your tree.

Keep your tree diary for as long a time as you want to. A tree diary kept for one year tells an interesting story. See if you don't think that a tree is an important part of nature!

A page from a tree diary:

April 10. The buds on the tree are getting bigger. I think my tree will have leaves before the other trees in our block.

April 11. This morning I counted over ten small yellow birds in the tree. They looked like they were hunting for insects. The bird book said that they were yellow warblers.

April 12. The warblers were gone this morning. I guess they have gone farther north to look for a place to nest.

April 13. Someone broke a large twig off of the tree today. I wonder what they wanted with it? I saw two more robins.

April 14. This morning there were hundreds of small red and black insects crawling around the trunk of the tree. I took one to school and the teacher said these are beetles that kill other bad insects. I am glad I didn't kill any of them.

April 15. It rained hard today and . . .

II. An aquarium (Plate I)

An aquarium is a place where you can keep water plants and animals. An aquarium can show many things about life in the water.

There are several ways to start an aquarium. You may want to use water animals and plants found in nature close to where you live. Other aquarium animals and plants can be gotten in a pet shop.

Here is a list of things that you will need for your aquarium:

1. An aquarium or tank: A good size for an aquarium is one that will hold five gallons of water.
2. Clean, coarse sand: About two inches of clean sand in the bottom

of the tank will be plenty. Run water over the sand to get the dirt out.

3. Water: After the clean sand is placed in the aquarium the water can be poured in carefully. Let the water stand in the tank for at least two days. Many times fresh water has things in it that will kill fish.

PLATE I

figure A.

tank type aquarium

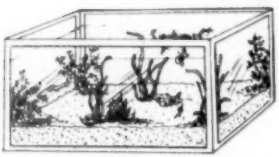


figure B.

large mouth jar aquarium

4. Plants: Water plants are needed in an aquarium. If you get your plants from a stream or pond take just a few to see if they will live. Run water over them to get off harmful water animals. Plant them in the sand unless they are the kind that float.
5. Snails: You will want three or four snails in your aquarium. They help to keep it clean. Get them from a pond or stream or buy them from the pet shop.
6. Fish: It is best to buy fish for your aquarium. Goldfish are nice to keep but you want to remember to keep only one inch of goldfish to each gallon of water. Goldfish do not like to be crowded. Tropical fish from the pet store are very good for your aquarium. Two or tree pairs of guppies would be very good for you to start with.
7. Food: You will want to take good care of your fish by feeding them the right kinds of foods. Food for goldfish and other fishes can be gotten at the pet shop. Small bits of shrimp, worms, or small insects like mosquitoes can be fed to the fish. Be careful not to feed them too much.
8. Heat and light: Put your aquarium where it will get some good light. The plants need sunlight in order to grow. Do not let the water get too hot or too cold as this may kill the fish.

9. A cover: You may want to put a piece of glass on the top of your aquarium. This keeps dirt out of the water and helps in other ways too.

Remember to take good care of your aquarium. There are many plants and animals you can keep there if you are careful.

III. Have fun with plants.

The world is full of many different kinds of plants. You can do many things with them in your home or school to learn more about nature.

You will be able to see how soil, water, and light work with plants so they can grow. You might be able to see how the plant can help the soil.

PLATE II

bottle garden "formula"

1. A project with a few seeds.

Maybe you know where you can get some sweet corn or field corn seeds. If you can't, you might find some peas, beans, or watermelon seeds.

Get a clear drinking glass and some sand. Pour sand into the glass until it is about two inches from the top. Plant a few seeds next to the glass so you can see them. Place them just under the sand. Now pour another inch of sand on top.

Pour some water on the sand so it will get damp. You do not want too much water though. Keep the sand moist and watch the seeds every day. Maybe you could keep a notebook with drawings on this project.

Things to watch for:

(a) The seeds will swell up before they sprout. They take in water to do this. See how much difference there is between a dry seed and the one in your glass?

(b) Watch for the root tip as it grows from the sand. It grows very fast. Which direction does it grow?

(c) If you have corn planted, a sprout will start pushing up toward the light. See how it turns green? Most plants must be green to be able to make food.
(d) If you have planted both corn and beans, watch them carefully. Is there any difference in the way they sprout?

You will not be able to grow full size plants in your glass but you can learn much about nature by doing this.

2. Big plants from seeds.

Do you ever have lemons or grapefruit at your house? Would you like to grow one of their seeds? It's easy!

Get a few lemon or grapefruit seeds. Put them away until you find one or more clay pots. Your pot should hold at least a cup of soil. Larger pots are better.

Put a stone over the hole in the bottom of the clay pot and pour in soil until it is about one and one-half inches from the top. Press the soil down lightly and lay a seed on it. Pour about one-half inch of soil or a little less over the seed. Water and wait. These seeds take longer than corn or beans to start.

When the plant becomes large you may have to move it to a larger pot.

3. A bottle garden. (Plate II)

There are many plants that grow well in a glass container. These plants grow best in warm, damp places. African violets, wandering Jew, small ferns, and some mosses are a few that will do well in a bottle garden.

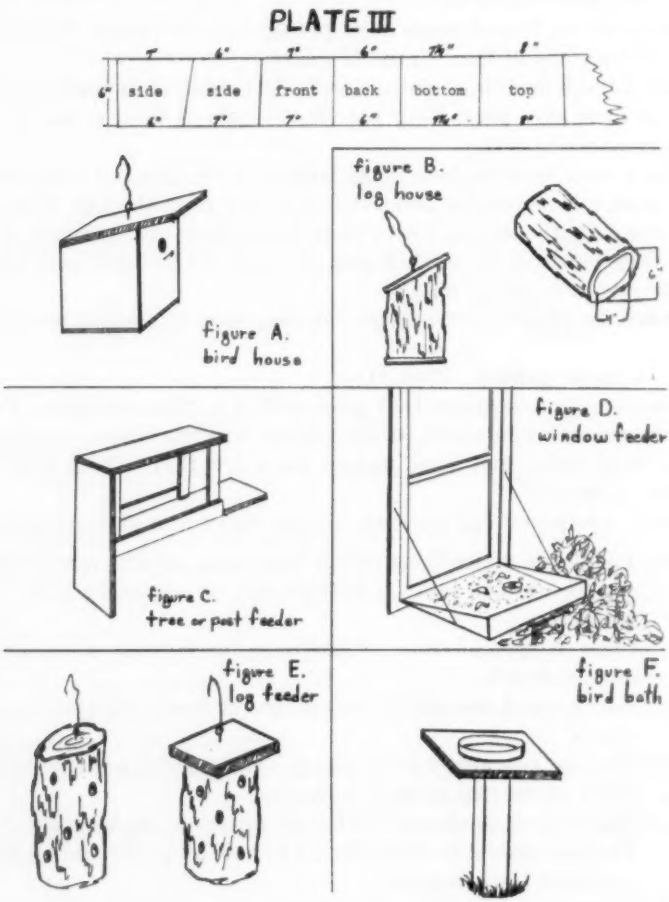
Here is how you can grow an African violet in a glass container:

(a) The bottle you will use might be a large jar with a wide opening, an old fish bowl, a battery jar, or any other large glass container.
(b) Place a layer of stone or gravel in the bottom, not over one inch in depth.
(c) Put one and one-half to two inches of good, rich soil over the stones.
(d) You are now ready for a plant. Try to find a healthy African violet about two or three inches tall.
(e) Make a hole in the soil with your fingers by moving soil aside. The hole should be wide enough to hold all of the roots without crowding them together.
(f) Carefully put the plant into the container. Let the roots spread out in the hole.
(g) Carefully cover the roots with soil. Press the soil gently so the plant will stand.
(h) Pour water over the soil until it is damp but not wet. Water must not stand in the bottom of the jar.

(i) If you place a cover on your bottle garden, be sure that it does not fit tightly.
(j) Place your garden by a window but don't let it get too hot.
(k) If the soil begins to dry, add only enough water to dampen it.
(l) Watch for your violet to bloom. Be patient!

Things you can make to help nature.

I. A bird house for wrens. (Plate III, fig. A)



Maybe you would like to build a bird house. This would be a big help to nature. Birds that are raised in this house will eat many harmful insects. You will also have fun watching them.

You could put your wren house in the yard near your home. It

should be placed at least six feet off of the ground where cats can not bother it.

Here is a plan for a wren house. You might get some one to help you make it. Maybe you can find different plans in other books. You will need:

1. One board 1 by 6 inches by 48 inches in length. You may use two or three shorter pieces if you do not have a long board. You will also need about two dozen nails.
2. Mark the board carefully with a ruler as it is in the picture. (Plate III, fig. A)
3. Saw carefully along the lines that you mark on the board.
4. Put together by placing sides on floor or bench the long edge down.
5. Put the back on the bird house. Put 2 nails through the back into each side piece.
6. Turn over and nail on the front in the same way.
7. Get top even with back and sides. It will stick over an inch in the front. Put 2 nails through the top into each side.
8. Turn the house upside down. Put bottom in place and put 2 nails through the bottom into the front and 2 into the back. If you want, you can hinge the bottom on so the house can be cleaned. Put a hinge on one side and a hook and eye on the other.
9. Drill a one inch hole in the front of the house two inches from the top. Put a nail about an inch below the hole for a perch.

Your bird house may be hung up by putting a hook into the center of the top.

You may nail the wren house to a post if you want by opening the bottom and driving a nail through the bottom into the post. Hook the bottom again and your house is ready for use. If there is a little paint around, you can paint the bird house.

Bird houses can be made out of many things. A hollow log about six inches in diameter could be used. (Plate III, fig. B) After you have found and hollowed out the log, a board must be carefully nailed over the open end or ends. Make a hole of the proper size with a brace and bit or knife, hang up the house, and it is ready for a bird family.

A tin can may be used for a bird house if it is placed in a shaded place. Metal gets very hot in the sun and the heat may kill the baby birds when they hatch.

II. A feeder for winter birds.

Many kinds of birds stay in the northern states during the winter. Sometimes it is hard for them to find food. You can help nature by feeding these birds.

Birds like bread crumbs, bits of fruit, suet, small grain like wheat and cracked corn, peanut butter, and different kinds of seeds. You could put these things in a bird feeder. Large pieces of food should be tied down so the birds will not carry them away. When the birds learn that your are kind to them many will come to your feeder.

A feeder may be placed on a window still. You could hang it near

the house or put it on a post. Put it where animals can not bother it or scare the birds when they come to feed.

Plate III, figure C, D, and E show feeders that you can make. You could use any pan that is flat and has sides like a cake or cookie pan. Wood can also be used to make feeders. Figure E shows a feeder which is made by drilling holes into a log. Peanut butter or suet is put into the holes. The long should have a rough surface so that the birds can cling to it as they eat.

III. A bird bath. (Plate III, fig. F)

In the summer time you could make a bird bath. You could make it by using a large cake or pie pan that will hold water. You could even use an old wash pan or bowl. Place your pan or bowl on a stool or something you make so it is off of the ground.

If the bird bath is near bushes or trees, more birds seem to use it. Be very careful that it is not in a place where cats will catch the birds.

Ways you can help nature:

1. Use paper and pencils wisely.
2. Eat all the food on your plate.
3. Be careful with your air rifle or sling shot.
4. Be careful with matches.
5. Throw trash in trash cans.
6. Take care of trees and shrubs. Don't dig or cut them unless absolutely necessary.
7. Keep the animals alive. Fires and guns may harm or kill them.
8. Build and keep places for birds to live.
9. Feed the birds in winter.
10. Obey all laws that are made to help the forests, water, and wildlife.
11. Help plant grasses and trees where they are needed.
12. Be careful how you use water; do not waste it.

Remember, when you help one part of nature you are usually helping much more than you think you are!

HOUSE FLIES MAY SPEED CANCER CURE

The lowly house fly may speed the discovery of a cancer cure, thanks to a new test developed by U. S. Department of Agriculture scientists.

Several anti-cancer compounds have been found to slow up the growth of ovaries in the female fly and so other chemicals are now being fed to the flies in milk. If any of these also slow ovarian growth, they may be useful in the fight against cancer.

Use of the flies would allow much quicker screening than is now possible with mice and rats. Results of fly tests can be obtained in as little as three days, and the house flies complete a life cycle in slightly more than two weeks.

GEOMETRIC DERIVATIONS OF SOME TRIGONOMETRIC FORMULAE

D. MAZKEWITSCH
College of Engineering, University of Cincinnati, Cincinnati 21, Ohio

1.

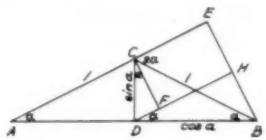


FIG. 1

Consider an isosceles triangle ABC, in which $AC=CB=1$. Through C draw CD perpendicular to AB. Then $AD=DB=\cos a$, $CD=\sin a$. Through B draw BE perpendicular to AC extended, through D draw DH parallel to AC, and through C CF perpendicular to DH. Then $\angle BCE=2a$, $\angle FCD=\angle FDB=a$. $EH+HB=EB=\sin 2a$, $CE=DH-DF=\cos 2a$. Now

$$EH=CF=\sin a\cos a, \quad HB=\sin a\cos a$$

$$DH=\cos^2 a, \quad DF=\sin^2 a.$$

Hence

$$EH+HB=EB=\sin 2a=2\sin a\cos a$$

$$DH-DF=CE=\cos 2a=\cos^2 a-\sin^2 a.$$

2. Consider an arbitrary triangle ABC and make $BC=1$. Make constructions as above. Then the formula for $\sin(\alpha+\beta)$ is obtained.

3.

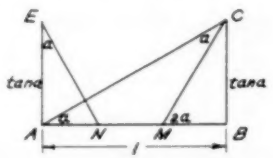


FIG. 2

On one side of angle a lay off $AB=1$ and erect at B BC perpendicular to AB, then $BC=\tan a$. At A erect AE perpendicular to AB and lay off $AE=BC=\tan a$. Through E draw EN perpendicular to AC, then

$$\angle NEA=a, \quad AN=\tan^2 a \text{ and } NB=1-\tan^2 a.$$

Connect the mid-point M of NB with C, then

$$MB=\frac{1-\tan^2 a}{2}, \quad AM=1-\frac{1-\tan^2 a}{2}=\frac{1+\tan^2 a}{2}$$

$$MC=\sqrt{\left(\frac{1-\tan^2 a}{2}\right)^2+\tan^2 a}=\frac{1+\tan^2 a}{2}.$$

Hence triangle AMC is isosceles, $\angle MCA=\angle CAM=a$ and $\angle CMB=2a$. From $\triangle MCB$

$$\tan 2a=\frac{BC}{MB}=\frac{\tan a}{\frac{1-\tan^2 a}{2}}$$

or

$$\tan 2a=\frac{2\tan a}{1-\tan^2 a}.$$

4.

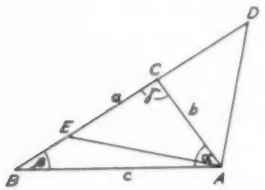


FIG. 3

In triangle ABC lay off on BC extended $CD=CA=b$. Then ACD is an isosceles triangle in which $\angle ACD=\alpha+\beta$,

$$\angle CDA=\angle DAC-90°=\frac{\alpha+\beta}{2}.$$

In triangle BDA

$$BD=a+b, \ \angle BAD=\alpha+90°-\frac{\alpha+\beta}{2}=90°+\frac{\alpha-\beta}{2}$$

and

$$\frac{BD}{\sin\left(90°+\frac{\alpha-\beta}{2}\right)}=\frac{AB}{\sin\left(90°-\frac{\alpha+\beta}{2}\right)}$$

or

$$\frac{a+b}{c}=\frac{\cos\frac{\alpha-\beta}{2}}{\cos\frac{\alpha+\beta}{2}}=\frac{\cos\frac{\alpha-\beta}{2}}{\sin\frac{\gamma}{2}}.$$

On BC lay off $CE=CA=b$. Then in triangle ACE

$$\angle ACE=180-(\alpha+\beta),\quad \angle CEA=\angle CAE=\frac{\alpha+\beta}{2}.$$

In triangle BAE

$$BE=a-b,\ \angle BEA=180-\frac{\alpha+\beta}{2},\ \angle EAB=\alpha-\frac{\alpha+\beta}{2}=\frac{\alpha-\beta}{2}$$

and

$$\frac{BE}{\sin\frac{\alpha-\beta}{2}}=\frac{BA}{\sin\left(180-\frac{\alpha+\beta}{2}\right)}$$

or

$$\frac{a-b}{c}=\frac{\sin\frac{\alpha-\beta}{2}}{\sin\frac{\alpha+\beta}{2}}=\frac{\sin\frac{\alpha-\beta}{2}}{\cos\frac{\gamma}{2}}.$$

5.

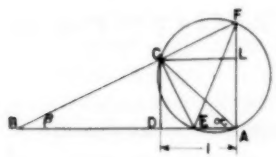


FIG. 4

In triangle ABC pass through C CD perpendicular to AB and make $DA=1$. Then $CD=\tan\alpha$. At C erect CE perpendicular to BC, at A erect a perpendicular to AB intersecting BC extended at F. Then:

$$\angle ECD=\beta,\quad DE=\tan\alpha\tan\beta,\quad EA=1-\tan\alpha\tan\beta.$$

$$\angle ACF=\alpha+\beta.$$

Through C pass CL parallel to AB. Then $\angle LCF=\beta$ and $LF=\tan\beta$. Consider quadrangle $FCEA$. Since the angles at A and at C are

right angles, the points A, E, C, F lie on one circle, and then $\angle AEF = \angle FCA = \alpha + \beta$. From triangle AFE we have

$$\tan AEF = \frac{AL + LF}{EA}$$

or

$$\tan(\alpha+\beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha \tan\beta}.$$

6.

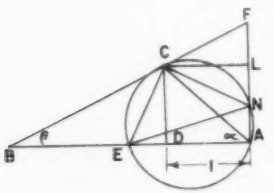


FIG. 5

In triangle ABC find the points D, L, F as in 4. Lay off $LN = LF$ and draw CE perpendicular to CN. Then

$$\angle LCN = \angle DCE = \angle LCF = \beta, \quad \angle NCA = \alpha - \beta,$$

$$CD = \tan\alpha, \quad DE = \tan\alpha \tan\beta, \quad AE = 1 + \tan\alpha \tan\beta$$

$$NL = \tan\beta, \quad AN = AL - LN = CD - LN = \tan\alpha - \tan\beta.$$

The points E, C, N, A lie on one circle and

$$\angle NEA = \angle NCA = \alpha - \beta.$$

From ΔAEN

$$\tan AEN = \tan(\alpha-\beta) = \frac{AN}{AE}$$

or

$$\tan(\alpha-\beta) = \frac{\tan\alpha - \tan\beta}{1 + \tan\alpha \tan\beta}.$$

TRANQUILIZERS NO CURE FOR MENTAL TROUBLES

Tranquilizers are not curing mental patients, they are shifting them from the hospitals to doctors' offices and out-patient clinics, a Philadelphia psychiatrist, told the American Medical Association.

Describing what can and cannot be expected from the new drugs, he said that the most they can do is to relieve symptoms. They do not cure the basic, underlying mental conflicts and are not enough treatment by themselves.

PERSONAL PROBLEMS OF A SCIENCE STUDENT

LOUIS J. CANTONI
Wayne State University, Detroit, Michigan

"Mr. Blue is here," the receptionist phoned me. It was Don Blue, referred for psychological counseling by his high school principal. A bright twelfth grader, he was failing a number of courses, was antagonizing several of his teachers, and, according to the principal, was "impossible" at home.

I went out to the waiting room to meet Don. He was a tall, slim, presentable young man. After introducing myself, I asked him into my office so that we could begin our talks. He sat down and although he looked alert he apparently was too shy to speak. I opened the interview by remarking casually:

I noticed that you were studying one of your school texts in the waiting room.

Well, replied Don, I was looking over these twenty-five pages I copied out of a chemistry book. I typed this list of all known chemical elements and compounds, with their formulas, so that I could have it around all the time and learn it by heart. I didn't do well all through the eleventh grade, and I'm off to a bad start again. Up to the eleventh grade I was an A student, with just a few B's. But I'm afraid I'll be lucky if I finish at all this semester, the way I feel about things.

Don hesitated a moment and then continued: I don't know. I think and think about it. I feel so discouraged at times, but I can't admit it to my folks or anyone. Last year the visiting teacher sent me downtown and I took a lot of tests. Later I saw the psychologist there and he gave me some of the results. My interests showed up where I know they are, in science and mathematics. He said my intelligence is way above average.

Yes, Don, I have seen these test results. I have also seen your achievement test scores in chemistry, physics, and mathematics and these, too, were very high. Now, can you tell me how you did in the eleventh grade?

It was pretty bad. The first semester I squeaked by with poor marks in everything. The second semester I got a failure in algebra. I was about to fail chemistry, too, but Mr. Sawyer turned out to be a regular guy. He let me write up some of my experiments late, and he gave me a passing grade. I guess I woulda got by in algebra, too, but I had a run in with the instructor, Mr. Black, and I took a failure rather than put up with his know-it-all attitude.

Your eleventh grade work didn't measure up to what you did on the tests you took downtown.

I know I'm smart enough. Right now, in chemistry, I'm just about as good as my brother is. He'll wind up his course work toward a Ph.D. in physics next June. My brother is really good. He's twenty-four years old, and he'll most probably have a doctorate when he's twenty-five. Chemistry is what I like. I know the school text backwards and forward, and I've been reading some others. Last summer I explained to my brother some chemical developments he hadn't even heard about. He tried to encourage me to get good grades this year.

Maybe, Don, your difficulty with studying and getting good grades is the result of something rather than the cause of the problem.

I suppose so, Don said slowly. But it's so hard to talk about. We have never got around to it at home. My folks tried to help me once or twice, I guess, but I just couldn't stand it and I'd lock myself up in my room. My father teaches bookkeeping. Maybe he thinks all problems are like something in a ledger book, like assets and liabilities. Maybe we can talk about my big liability next time.

Second Interview

Don's eyes sparkled when he came into the office, but even so his face appeared clouded by conflict and indecision. When he asked, "Are you ready to start?" he was, I thought, asking the question of himself.

I've been thinking things over the way my father does. It's funny, but my assets have changed to liabilities. I really tried last week. I wrote up the chemistry experiments, but there are still some back ones. My algebra teacher this semester, Miss Beach, is really human, but somehow I can't get my homework done for her. I stall around, looking at the algebra book. Then I give up and read the newspaper over and over, or I watch TV.

You want to do what you think is right, but for some reason you find you can't do it.

Look, two summers ago I was in the Juvenile Detention Home. (*He looked at me a little defiantly.*) I haven't told this to anyone, but maybe I can tell you. Maybe I can get it all off my chest. I tell myself it's something past, something forgotten, but it keeps coming up in my mind all the time.

Don continued: I guess it was because I was worried about putting up a garage. We've been living at our place for ten years but have never had a car. My father has been saying for the past ten years that he'll get a garage built and then he'll buy a car. They were building some new houses in our neighborhood and I found myself picking up scrap lumber and nails. The thing grew and grew. I suppose way at the back of my mind there was that idea about a garage.

Then one afternoon about the middle of summer two men came to

the house. My mother was in the back yard and they talked with her first. I went out of the house and they sort of jumped on me. They pointed at the lumber I had stacked behind an old playhouse. They looked into the playhouse and found three kegs of new nails. My mother almost fainted. They said they were detectives and I'd have to go with them. They pushed me into their car and drove me to the Juvenile Detention Home.

My mother came to the Detention Home later that day. She wanted to see me and offered to settle the matter, financially, in any way they wanted. They didn't let her see me. They told her I would be held until I was seen by the judge in Juvenile Court. I felt sick through and through.

I was scared silly, but I figured I would try and make the best of it. I was there five days and they treated me like a criminal. I didn't see my folks or my brother all that time. The boys were rough and swore all the time.

On the second day, when the other boys and I were lined up, a kid about fifteen broke from the line and began yelling and running around like mad. He tried to hide under a bed, but three custodians caught him and hauled him out of the room. He kicked and screamed like he'd gone crazy.

As soon as I could, I volunteered to work in the kitchen. I wanted to keep busy and forget what happened to that boy, but I couldn't. I was afraid I'd lose my grip on myself and the same thing would happen to me. I've had that fear right to this day, but I've never talked it over with anyone.

Don paused, exhausted after revealing his lonely fear. I reassured him: Don, I know how hard it's been for you to talk about something you've kept to yourself more than a year. But now we can look at what it's meant to you and what you might try and do about it.

That's right. I just couldn't tell anyone. This may sound silly, but I felt like my folks were partly to blame for not even noticing when I brought home the lumber and nails. Anyway, we gave them back their building material and I paid $50.00 out of my savings for stuff the builders said was still missing.

However else this has affected you, Don, it has hurt your chances of getting good grades at school. Is this something you want to work on?

It sure is. I suppose I'm still so mad and upset about being taken to the Dentention Home that I can't do anything! I can't study what I'm taking in school, but it's kinda relaxing to study college organic and inorganic chemistry. I've been pretending that what happened to me didn't happen. But I don't have to do that anymore. Somehow I feel like I've just taken off a blindfold and can see daylight again.

THIRD INTERVIEW

Except for one day, Don began, I felt grand all this past week. And I did all the week's assignments, except one for math. I talked to some old boy friends and it seemed like they were really still friends. It hasn't been this way for more than a year. My study problem doesn't seem so big anymore.

Could you tell me what happened the day you didn't feel very well?

Oh, my mother was having trouble with her sewing machine. It wouldn't run. I coulda fixed it, too, but my mother just put me aside. She said Dad would take care of it when he got home. Then she said something she hasn't said in a long time, that I oughta use my time for study.

You feel, however, that your mother thought you could repair the machine?

Yes, I do. That's the saving part about it. I guess she's really interested in me and my problems. I used to resent any suggestions. I felt I didn't have to do anything for my folks after the Detention Home. I suppose, though, that they were as mad and upset as I was. But I still resist algebra. And I've been through the whole book. It's a matter of homework. We had a test last week and I got a good grade. Miss Beach is fine, she's human.

You didn't think that about Mr. Black.

No, I didn't. I still hate him. He thought he knew it all. He was sharp and nasty, just like those men who came to take me to the Detention Home. You couldn't talk or reason with him. He had the answers, he'd show you the evidence. Maybe he knew about the lumber trouble and was holding that against me.

It's not probable that he knew—or do you think so?

No, it's not probable.

And if he did know, would he see you in that light in an algebra class? He had nothing at all to do with the lumber episode.

It doesn't make sense that he should hold it against me even if he did know. Through the tenth grade I used to be one of the top math students. I suppose I showed it in class. But in the eleventh grade I couldn't produce. I acted like I knew the stuff, but I was never prepared. When Mr. Black had me go to the blackboard to do a problem, I couldn't finish it. Then it seemed to me he made sly remarks. I was still thinking about the Detention Home. I had gone through that all by myself, and people like Mr. Black didn't understand or appreciate it. I was mad at myself because I was in a rut, and it was easy to hate a teacher like Mr. Black, who knew all the answers and could produce all the evidence.

You want to be free to say something about what happens to you.

Yes, I do. I don't think I just naturally hate people like Mr. Black.

My father's always been stern, but he's been fair, too. He's not always included me in planning things I should have known about, but he's no tyrant.

You don't think your father is a tyrant, but he has been stern. Could the same understanding apply to Mr. Black and the detectives—were they not performing a duty as they saw it?

Yes, they were. But I wasn't ready for people like them. I feel that I am now, though. There are all sorts of people. Some make a mean thing of the authority they have. I shouldn't let them throw me. People like Mr. Black are not in charge of what I do—I'm the one who's responsible.

Fourth Interview

You know, I feel like a man now, Don said, especially where thinking things through is concerned. I see now I had my algebra mixed up with Mr. Black. Because I hated him, I got to hate algebra. And math—figures anyway—math is what makes the men in my family tick!

From what you said about your father and brother, I would agree with you there.

And another thing. I've been jumping the gun. I was all fogged up by what happened at the Detention Home. Because I couldn't get a grip on myself, I felt I had to reach my goals right away, or I'd never get them. I was working on a Ph.D. all by myself when I should have been doing my day-to-day studying. Why, at the beginning of this semester I spent days typing that twenty-five page list of the names of all known chemical elements and compounds, with their formulas. I was going to learn the whole list, just the way it was. Neither my parents nor Mr. Black knew what a struggle it was to carry on from day to day.

You tried very hard to work things out by yourself.

I needed help, Don said simply. I've always been able to approach people, to be friendly, but the fear that started in the Detention Home was something I couldn't share, not with my folks, or brother, or anyone. I want to get into the social swing of things again. I'm beginning to make new friends at school, both boy and girl friends. I'm finding out they have their problems, too, and I enjoy talking over with them the things that happen from day to day. I don't know, I might make the grade yet. Anyhow, thanks . . .

Seven years passed before I saw Don again. He did not come back to my office. I happened to see him in an all night restaurant. I had stopped for a cup of coffee and it was about 1:00 A.M. I recognized his handsome face with the bright eyes and distraught expression. His suit was a network of wrinkles and he needed a shave. With a

shock I visualized Don's life as a total loss. Everyone had failed him —parents, teachers, counselors, including myself. Seven years ago a lonely, sensitive boy had come to me for help but had been left to fall by the wayside instead.

Suddenly he was standing before me.

"Know me?" he says, through bleared eyes.

I nod.

"Well, have one"—he thrusts a cigar at me—"I just had my first baby—a boy! I mean my wife did!"

I congratulated him on his good fortune and chatted with him about the usual amenities.

"You know," Don said, "I've thought about you every once in a while since high school days. I was thrown pretty hard by that Detention Home experience. Sometimes, during the eleventh and twelfth grades, I used to wonder how I could keep going. Anyhow, I finished high school all right and went on to college to get a bachelor's and a master's degree in chemistry. I have a good job as an industrial research chemist, a wonderful wife, and now a son!

"Do me a favor, will you? When you go the office tomorrow, dig out my old counseling record and write at the end, 'And he lived happily ever after.' So long!"

ACCURATE PREDICTIONS OF HURRICANE PATHS FORESEEN

Detecting the formation of hurricanes and predicting the paths of these giant tropical storms for several days in advance are foreseen in a report issued by the Smithsonian Institution.

R. C. Gentry and R. H. Simpson of the Weather Bureau's National Hurricane Research Project, West Palm Beach, Fla., reported that meteorologists are now making "considerable progress" in understanding the basic mechanisms of hurricanes. They believe some day it may even be possible to put "power brakes or steering wheels" on the great storms.

Doing this, however, means obtaining control of as yet unknown forces in hurricanes themselves. The natural force of the great storms is so much stronger than anything man can ever hope to bring against it that control by any external means probably will always be impossible.

Radar and storm-plunging reconnaissance planes are two fruitful sources of hurricane information.

The discovery of spiral rainbands is among the recent findings concerning the tropical storms. Most of the heavy rain in hurricanes, the second greatest factor in loss of life and property damage, occurs in rainbands that spiral inward toward the storm's center. Between these bands, rainfall is relatively light and near the outer edges there frequently is no rain at all.

Most hurricanes, it is now known, have several centers that may or may not be the same. There is the center of wind circulation, the point of lowest air pressure and the point around which the spiral rainbands, or "cloud streets," rotate. Location of these centers may differ by as much as 20 miles.

Hurricanes frequently move along an irregular path that wanders back and forth across the relatively straight path the storms were previously believed to have followed. Some of these oscillations have a short period of three to six hours, some a period of 12 to 36 hours.

MAN'S ENERGY SOURCES

GERALD OSBORN
Western Michigan University, Kalamazoo, Michigan

In a recent article[1] in SCHOOL SCIENCE AND MATHEMATICS, the author re-examined the conservation of matter law in terms of the Einstein formula. All of the physical universe can be classified under two headings, namely, matter and energy. We in America enjoy an unusual high standard of living because we have so effectively made use of the various sources of energy. Let us briefly review these sources found here on the earth. They are (1) the sun, (2) man controlled nuclear reactions. From the dawn of history until around 1945 man had depended on the sun for his energy source. Energy from the sun may be listed as follows:

(a) More direct energy sources
  (1) From water fall
  (2) From growing plant products, such as, sugar, starch and cellulose, etc.
  (3) Solar batteries
(b) Fossilized (or stored) energy
  (1) coal
  (2) petroleum
  (3) natural gas

Switzerland depends on her energy source from the water fall. This supplies Switzerland with considerable electrical energy. For this reason her trains are pulled by electric motors. This is also somewhat true of many of the Scandinavian countries. It is evident that water falls are a good source of energy because the sun has lifted water by evaporation from a low level to a higher level. Especially in the West, the United States has successfully harnessed water falls. The Boulder Dam on the Colorado River and the Grand Coulee Dam on the Columbia River are examples of how this has been done on a large scale.

We all know that man consumes sugar, starches, and fats in order that they may be oxidized in his body to give him energy. The following equation represents the oxidation that takes place within the human body.

Equation 1: $C_6H_{12}O_6+6O_2 \rightarrow 6CO_2+6H_2O+\text{energy}.$

If 180 grams of sugar is thus oxidized 672,000 calories of energy will be released. One might ask: is the sun the source of this energy? The

[1] Osborn, "A Modern Look at the Conservation Laws," pp. 345–346, SCHOOL SCIENCE AND MATHEMATICS, May 1957.

answer is yes through a process we call photosynthesis. You who are students of biology know that the green coloring material in the plant is chlorophyll and that this catalyzing agent under the influence of sunlight brings about a chemical reaction in which simple sugars are formed and oxygen is evolved. The chemical reaction may be expressed by the following equation:

Equation 2: $6CO_2+6H_2O+\text{Energy}\rightarrow C_6H_{12}O_6+6O_2$
(from sun) a simple sugar

If a total of 180 grams of sugar is thus formed the energy from the sun is equivalent to 672,000 calories. This is the same quantity of energy that we got when we (see equation 1) oxidized the 180 grams of sugar. Thus we see how this energy really came from the sun. Plants may store the sugar as sugar or they may convert the sugar over to starch and cellulose. When we burn wood to get heat the cellulose is the main source of energy.

Since around 1800, with the rise of the modern industrial age that came with the harnessing of steam, man has depended to a large extent on the burning of coal, petroleum products, and natural gas as his source of energy not only to heat his homes but also to power his large manufacturing plants. Briefly, geologists tell us that coal and petroleum were once living plants and organisms that got covered up by earth and water and underwent decomposition. This all happened ages ago. Hence we call it fossilized energy. We can readily see that it is a kind of canned sun heat. For the past 150 years man has depended mainly on this form of stored up energy, but these sources are being rapidly depleted.

National income depends upon effective energy consumption. The United States and Canada are well ahead of Western Eurpoe in energy consumption and Western Europe in turn is ahead of the Orient. For example, in 1952[2] the per capita energy consumption expressed in long tons of coal was as follows in the following countries.

United States	8.0 tons
Canada	7.5
United Kingdom	4.8
France	2.6
Japan	0.8

The per capita national income in U. S. dollars for 1952[2] was as follows in the same countries.

United States	$1850
Canada	1270
United Kingdom	870
France	764
Japan	193

[2] E. S. Mason, International Conference on the Peaceful Uses of Atomic Energy.

From the above data it becomes apparent that the standard of living within a country is directly proportional to the efficient manner in which it can utilize energy. Summarizing, the greater the per capita consumption of energy the higher the standard of living.

Our present industrial age requires enormous quantities of energy. The following table[3] illustrates this fact.

FUEL CONSUMED IN PREPARING ONE TON OF VARIOUS COMMODITIES

Commodity	Fuel (In Coal Equivalent)
Titanium	4½ tons
Aluminum	2 tons
Magnesium	1¾ tons
Steel	1¾ tons
Rubber	2 tons
Paper	2 tons
Glass	1 ton
Cement	⅓ ton

England is an example of a country which can no longer depend to any extent on fossilized energy sources. England once had rich coal fields but these mines have been worked hard for a great many years; the best seams were exploited first; the coal is now hard to mine and many of the pits are very deep. The coal thus obtained is of poorer quality as the heavy fuel consumption has made it necessary to extract coal from thinner and dirtier seams. In contrast the United States has very large coal reserves, much nearer the surface and easily mined. The difference is clearly reflected in price; U. S. coal on the average costs only half as much to produce as European coal. Both Europe and England purchase coal from the United States.

In comparison to England the United States has much larger resources of water power which produces very cheap electricity. In 1952 British consumption of hydro-electric energy was less than 2% of the American figure. Further it can be added that in the U. S. A. the untapped economic water power potential is still very large. America is also rich in natural gas and petroleum resources as compared to Europe.

The above facts help to explain why England and the European countries are looking to nuclear energy for their power source. The nuclear reactor known as Calder Hall was opened by Queen Elizabeth II on October 17, 1956. The United States can be more deliberate in the developing of nuclear energy plants. However, some 36 plants are

[3] An unpublished paper delivered by Mr. K. T. Spencer, Chief Scientist, British Ministry of Power, at Ashridge College on Monday, July 15, 1957.

operating or under construction in the United States.[3] One such plant is located near Monroe, Michigan. Certain electric power companies within the area have pooled their resources in order to develop the Monroe plant. Many chemists feel that our coal and gas resources should be conserved for the manufacture of valuable chemicals and that we should depend more upon hydro-electric and nuclear plant developments for our source of energy.

The existing nuclear energy plants are based mainly on atomic fission rather than atomic fusion. However, since the supply of uranium and other fissionable material is less abundant than Hydrogen (a fusionable material) it would seem wise to gradually develop fusionable nuclear reactors.

To summarize we can say that man in the earlier periods of history depended upon his own hands, or those of a slave or some form of animal-power to supply his energy. The Pyramids were probably built by slave labor. Today a single American workman has horsepower available which is equivalent to over 270 slaves. Slave labor was followed in the middle ages by draught animals. Then in the 17th and 18th centuries came the steam engine which depended upon coal. Around 1890 the internal combustion engine which depended on a liquid fuel was developed. For the last half century we have depended on a combination of coal, petroleum, natural gas and hydroelectric power to provide our sources of energy. As the sources of petroleum, natural gas, and coal are gradually exhausted we will be forced to depend even more on hydro-electric and nuclear sources for our supply of energy.

Within the past decade Professor Farrington Daniels of the University of Wisconsin has emphasized that ultimately man must learn how to get his energy directly from the sun. Many research scientists are endeavoring to accomplish this purpose including Charles F. Kettering, ex-director of General Motors Research Laboratory. The so called "solar battery" developed and used by the Bell Telephone Company is a way of getting energy directly from the sun. The cells are made of wafers of especially prepared silicon which are extremely sensitive to light and can be linked together electrically to deliver a power of 110 watts from sunshine having a maximum power of 1000 watts per square yard. We thus observe that the efficiency is about 11 per cent and it may become as large as 22 per cent. Such cells might yield as much as 700 horsepower per acre.

Since with the single exception of nuclear reactors all forms of energy seem to come directly or indirectly from the sun, we may logically ask; how does the sun get its energy? Through experimentations on transmutations revealed by cyclotron studies, Bethe (Cornell, 1939) proposed the following mechanism:

(a) ${}_1H^1 + {}_6C^{12} \rightarrow {}_7N^{13}$
(b) ${}_7N^{13} \rightarrow {}_6C^{13} + e^+$ (a positron)
(c) ${}_1H^1 + {}_6C^{13} \rightarrow {}_7N^{14}$
(d) ${}_1H^1 + {}_7N^{14} \rightarrow {}_8O^{16}$
(e) ${}_8O^{16} \rightarrow {}_7N^{15} + e^+$
(f) ${}_1H^1 + {}_7N^{15} \rightarrow {}_6C^{12} + {}_2He^4$

Total ${}_4{}_1H^1 + {}_6C^{12} \rightarrow {}_6C^{12} + 2e^+ + {}_2He^4$

Thus we might say that carbon plays the roll of a carrier type of catalyst since it is regenerated in the end. Basically the real reaction consists of four gram atoms of hydrogen of weight (4×1.008) 4.0320 grams reacting to form a gram atom of Helium of weight 4.0039 grams. By subtracting this second weight from the first weight we get a total of 0.0281 g. of matter which has disappeared and been transformed into energy.

Since $E = mc^2$ (Einstein formula)

$$E = .0281 \text{ g} \times (3 \times 10^{10})^2 = 2.53 \times 10^{19} \text{ ergs}$$
$$= 2.53 \times 10^{12} \text{ joules} = 6 \times 10^{11} \text{ calories.}$$

In conclusion we may re-emphasize that man's high standard of living is dependent upon an abundant source of energy. Our scientists and engineers are faced with the problem of furnishing this ever abundant supply of energy.

NATIONAL SCIENCE FOUNDATION Announcement of
Academic Year Institutes for High School Teachers of Science and Mathematics

Recent international scientific news has thrown a dramatic spotlight on the urgent need for scientific and technical leadership to enhance the progress and security of our Nation. High school teachers play a key role in developing our scientific manpower potential. The Academic Year Institute program is designed to help colleges and universities in their efforts to provide high school teachers of science and mathematics with better knowledge of their subjects and means of improving their teaching capabilities. It will provide opportunity for the science teacher to undertake courses in the subject matter of science and mathematics especially designed for him and conducted by faculty members noted for competence in their fields and for skill in presentation. These programs will also increase the teacher's capacity to motivate students to consider careers in science, mathematics, and engineering. Each Institute will provide for adaptation of the curriculum to individual needs.

ADMISSION POLICY

Admission to the various Institutes will be controlled by the requirements of the schools involved, each having somewhat different criteria for admission to the Graduate School. The Foundation has established the policy that candidates shall be considered primarily on the basis of professional competence and promise as teachers of science and/or mathematics. These Institutes have been designed to provide the type of supplementary training in the subject matter of science needed by the typical high-school teacher with little or no more formal education

than that represented by a bachelor's degree. The selection process is therefore likely to favor such applicants as contrasted with those who have already completed work for a master's degree in science.

Stipends

The Foundation grants for the Institutes will provide for a maximum stipend of $3,000, plus additional allowance for dependents ($300 each, up to a maximum of four dependents) and travel (two round trips from home to Institute at the rate of 4 cents per mile, with a maximum of $80 each round trip). Tuition and other fees will also be covered, as well as an allowance for books. Financial assistance will be available to some 800 teachers, about 50 at each Institute.

Inquiries

Inquiries concerning admission to a particular Institute should be sent directly to the Director of that Institute at the address listed. The National Science Foundation does NOT grant individual admission to the schools nor provide detailed information as to their requirements.

Academic Year Institutes, 1958–59[1]

Host Institute, Director, and Institute Address

Chicago, University of: Prof. E. P. Northrop, Eckhart Hall, Box 23, University of Chicago, Chicago 37, Illinois.

Colorado, University of: Prof. W. E. Briggs, 318 Hellems Annex, University of Colorado, Boulder, Colorado.

Illinois, University of: Prof. Joseph Landin, Department of Mathematics, University of Illinois, Urbana, Illinois.

Iowa State Teachers College: Prof. R. A. Rogers, Department of Science, Iowa State Teachers College, Cedar Falls, Iowa.

Michigan, University of: Prof. F. D. Miller, Department of Astronomy, University of Michigan, Ann Arbor, Michigan.

North Carolina, University of: Prof. E. C. Markham, Department of Chemistry, University of North Carolina, Chapel Hill, North Carolina.

Ohio State University: Prof. J. S. Richardson, 208 Communications Laboratory, Ohio State University, Columbus 10, Ohio.

Oklahoma State University: Prof. J. H. Zant, Department of Mathematics, Oklahoma State University, Stillwater, Oklahoma.

Oregon State College: Prof. S. E. Williamson, Department of Science Education, Oregon State College, Corvallis, Oregon.

Pennsylvania, University of: Dean W. E. Arnold, School of Education, University of Pennsylvania, Philadelphia 4, Pennsylvania.

South Dakota, State University of: Prof. C. M. Vaughn, Department of Zoology, Medical and Science Building, State University of South Dakota, Vermillion, South Dakota.

Syracuse University: Dr. A. T. Collette, 400 Lyman Hall, Syracuse University, Syracuse 10, New York.

Texas, University of: Prof. R. C. Anderson, Chemistry Department, University of Texas, Austin 12, Texas.

Utah, University of: Prof. T. J. Parmley, Room 215, Physical Science Building, University of Utah, Salt Lake City 12, Utah.

Virginia, University of: Prof. J. W. Cole, Jr. Department of Chemistry, University of Virginia, Charlottesville, Virginia.

Washington University: Prof. E. U. Condon, Department of Physics, Washington University, St. Louis 5, Missouri.

Wisconsin, University of: Prof. C. H. Sorum, Chemistry Department, University of Wisconsin, Madison, Wisconsin.

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[1] The Institutes at the University of Chicago and the University of Illinois will offer courses only for teachers of mathematics; the others will provide work in the various fields of science as well as mathematics.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

REPORT OF THE FIFTY-SEVENTH CONVENTION

NOVEMBER 28–30, 1957, CONGRESS HOTEL, CHICAGO, ILLINOIS

I. BOARD OF DIRECTORS MEETING

THURSDAY, NOVEMBER 28, 1957, 4:00 P.M., LAKE SHORE ROOM

Roll Call: Officers: Bos, Soliday, Terhune; Board Members: Ayer, Conrey, Gourley, Gross, Hach, Hauswald, Huffer, McCormick, Read, Shetler, Sister Evarista, Wren; Journal Officers: G. Mallinson, J. Mallinson; Membership Chairman Kennedy.

President Bos presented the agenda for both afternoon and evening board meetings.

The minutes of the spring board meeting were read and approved with one correction. The profit of $149 should be credited to the 1955 *Yearbook* rather than the 1956 *Yearbook*.

Reports of 1957 Convention:

Mr. Bos announced that illness prevented the attendance of Mr. Panush at the afternoon meeting.

Mr. Soliday reported more than 200 paid reservations for the Argonne National Laboratory trip. He announced that arrangements had been made for a demonstration of closed circuit television at the Friday morning program with a 14 receivers to be placed in the Francis I and the Gold Rooms.

Mr. Bos announced that Dr. Meder would be unable to appear as scheduled and would be replaced by Dr. Van Engen on the Friday afternoon program.

Reports of Standing Committees:

Treasurer and Business Manager: Mr. Soliday stated that 370 advance reservations received for the convention. Previous years' advance reservations usually numbered about 100. He reported that the audit shows that the Association broke even this year except for a $600 depreciation in the value of the unsold copies of the Anniversary Book. *Journal* circulation is again up and is larger than it has ever been. The raise in advertising rates did not discourage advertisers who had previously been with the *Journal*.

Journal Editors: Mr. and Mrs. Mallinson reported that the average time put in per month on the preparation of the *Journal* is about 100 hours. They exhibited form letters that they have prepared to cover various situations which come up in the editing of the *Journal*. Investigation has shown that the Banta Co. is doing the printing of the *Journal* at as low a cost as is possible. Mr. Mallinson mentioned the need for reorganization of the department editors, the need for a policy concerning book reviews, and the need for criteria for the format of articles submitted to the *Journal*. These topics are to be the subject of discussion at a meeting of the *Journal* editors with the departmental editors on Friday.

Membership Chairman: Mr. Kennedy announced that the membership of the CASMT as of November 27 was 1190, an increase of 143 members. He reported that during 1957 344 persons joined or renewed memberships after a lapse of one year or more. Fifty of these new members were brought in through the efforts of the membership committee by letter or personal contact; the remaining number he credited to the work of the Board and Association members.

Policy and Resolutions Committee Chairman: Miss Hach presented a report on the representation on the Board of Directors during the past 10 years showing the distribution by subject fields and the distribution by states. The report included also the distribution by states of the total membership of the Association. The five states which led in representation on the board were the same

five states which led in total membership in the CASMT, these states being Illinois, Michigan, Indiana, Wisconsin, and Ohio. Board membership during these years has been fairly well balanced between the two fields of science and mathematics. In total membership of the Association, science has led throughout the ten year period, although in recent years the difference has been lessened.

Yearbook Editor: Mr. Shetler presented the financial statement for the 1957 Yearbook. It was moved by Read, seconded by Ayre, to accept the report. Carried.

Location of 1958 Convention: It was moved by Wren, seconded by Read, that the board accept the invitation of Indianapolis to hold the 1958 convention in that city. Carried.

It was moved by Read that President Bos be instructed to appoint a committee from the Board of Directors to select a convention city for 1959. Seconded by Conrey. Carried.

New Business: Mr. Bos read a letter from the Association secretary presenting her resignation from that position, to be effective upon completion of the work of this convention. It was moved by Huffner, seconded by Hauswald, that the resignation be accepted with regret and appreciation expressed for past work. Carried.

The meeting was adjourned to reconvene at 7:30 P.M.

II. OPEN MEETING OF BOARD OF DIRECTORS

NOVEMBER 28, 1957, LINCOLN ROOM, 7:30 P.M.

Topic: The Future of CASMT—What Are We Working For?

I. *Formal Report Summaries:*

Policy and Resolutions for 1957—Alice Hach. Miss Hach discussed the report presented to the board at the afternoon meeting and reported in part I of these minutes.

Status of Association Finances—Ray Soliday. Mr. Soliday stated that the financial affairs are more encouraging now than they have been for some time, but that the final convention report would determine the truth of this statement. Income and expenses have increased in about the same ratio over the last several years. Approximately one-third of the *Journal* circulation is to CASMT members and two-thirds to non-members, including libraries. The Association has a reserve fund of about $5000.

Membership—Joe Kennedy. Mr. Kennedy discussed the efforts of the committee to secure new members, mentioning that letters of invitation had been sent to some 1000 teachers. Other duties of the committee were the preparation of the list of members for publication in the *Yearbook* and assisting with the convention registration. His report also included the statistics on membership given at the afternoon board meeting.

Proposed Revision of the Constitution—F. Lynwood Wren. Mr. Wren distributed copies of a three-page proposal for plans for the nomination and election of officers and the changes necessary in the Association By-Laws if the plan were to be adopted. Action on the proposal is a part of the business of the annual meeting on Saturday.

Your Journal—George Mallinson. Mr. Mallinson repeated his report given to the board in the afternoon. He stressed that material must be submitted in final form, as the cost is high if re-setting of type is needed. He urged that diagrams be submitted in good form.

II. *Highlights from 57 Years of CASMT—W. R. Teeters, Past President for 1937.*

Mr. Teeters reviewed the history of the *Journal* and the foundation of the Association. He mentioned the high quality of leadership of the Association given by its officers and board members, and stressed the attention given by the Association to the needs of the superior student as long ago as the early twenties.

III. The Future of CASMT—Milton Pella, Past President for 1955.

Mr. Pella gave as his understanding of the purposes of CASMT to foster better teaching in science and mathematics and to make evident the interdependence of the two fields. He expressed as future needs for the Association: 1) some kind of aggressive membership campaign; 2) continuity of leadership from year to year, with perhaps someone serving as a permanent full-time leader; 3) a program for CASMT which other competing organizations do not offer; 4) publication of more class room procedures which teachers can utilize; 5) more emphasis in the *Journal* on reporting research done in the fields of teaching of mathematics and science; 6) more emphasis on the elementary school level; 7) a statement of specific objectives for which CASMT stands.

Discussion followed.

A count of the members present showed 75 in attendance.

The meeting was adjourned at 10:00 P.M.

III. ANNUAL BUSINESS MEETING

SATURDAY, NOVEMBER 30, 1957, LINCOLN ROOM, 9:00 A.M.

The meeting was called to order by President Bos at 9 A.M. Mr. Bos expressed his appreciation to the Association for the trust they had given him with his election to the presidency and his appreciation to the persons assisting in planning the 1957 convention.

The president then announced that emeritus memberships were being awarded to: Mr. F. R. Bemisderfer, Cleveland, Ohio; Mr. Walter H. Carnahan, Lafayette, Ind. Mr. W. R. Teeters, St. Louis, Missouri; and to Mr. Wilbur Lee Beauchamp, Chicago, Illinois.

It was moved and seconded that the minutes of the 1956 convention be approved as published in the *Journal*. Carried.

Constitution Revision Committee Report: Mr. Wren presented the report for the Constitution Revision Committee. Part I of the report, dealing with a proposed plan for the nomination and election of officers, was read by Mr. Wren, who moved its adoption. The motion was seconded by Mr. Hauswald. Mr. Gingery moved that the words "according to the By-laws" be added to sentence 2 of paragraph 3, making the sentence read "All nominees must be members of the Association currently in good standing and properly qualified according to the By-Laws." The motion to amend was seconded by Mrs. Wilcox and carried. The original motion as amended was then carried. Part II of the report, dealing with changes in the By-Laws necessary to inaugurate the plan for nomination and election of officers, was read. Mr. Wren moved its adoption. Mr. McCormick seconded the motion. In the discussion of the motion the following suggested minor changes were made: In Article V, Section II, (f) insertion of "according to the By-Laws" to clarify the word "qualified," as voted on the acceptance of the Part I of the report. Mr. Neckers moved that Article III, Section III (a) be amended by the insertion of "the members of the Association through," making that sentence read "The President and Vice-President shall be elected by the members of the Association through a majority of the votes cast by the members of the Association. . . . " and that Article IV, Section IV be similarly amended to read "Directors shall be elected by the members of the Associtaion by a plurality of the votes cast by the members of the Association. Etc." Seconded by Mr. G. H. Miller. Carried. The original motion to adopt the proposed changes in the By-Laws was then carried with one dissenting vote.

Report of the Nominating Committee: Mr. Vernon Price, chairman of the nominating committee, discussed the procedure used in selecting names for consideration. All persons eligible under the terms of the By-Laws were canvassed by mail to determine their willingness to serve if elected. The following slate was presented: President, Louis Panush; Vice-President, Clyde T. McCormick; Board of Directors to 1960: Alice Hach, Robert Grubbs, Neil Hardy, and Hobart Sistler. Mr. Price moved the election of the slate. Seconded by Mr. Wren. Carried.

It was moved by Mrs. Wilcox, seconded by Mr. Wren, to extend congratulations to the present officers for the excellent work done on the 1957 convention. Carried.

The meeting adjourned at 9:45 A.M.

IV. BOARD OF DIRECTORS MEETING

SATURDAY, NOVEMBER 30, 1957, LAKE SHORE ROOM

Roll Call: Bos, Panush, Soliday, Terhune, Ayre, Conrey, Gourley, Gross, Grubb, Hach, Hardy, Hauswald, G. Mallinson, McCormick, Read, Shetler, Sistler, Sister Evarista, and Wren.

Policy and Resolutions Committee Report: Miss Hach presented the following resolution:

> "In view of recent events in our world situation with its impact on science and mathematics education, be it resolved that the Central Association of Science and Mathematics Teachers re-dedicate itself to meet this challenge and opportunity to be of service to mankind and to our nation within the framework of our democratic society."

It was moved by Read, seconded by Gross, that the resolution be adopted. Carried.

Two recommendations offered by the committee were deferred for consideration of the new board.

At this point Mr. Bos relinquished the chair of the president to Mr. Panush. Miss Hach expressed the thanks of the board to the retiring board members and to the retiring president.

Mr. McCormick, reporting on the section officers meeting, announced as the theme for 1958 "The Challenge of Science and Mathematics in a Free World."

President Panush requested the secretary to send to the officers and board members a breakdown on attendance figures at section and general meetings. Total attendance at the convention was 834.

Mr. Mallinson, reported on the morning meeting of the *Journal* department editors, presented the following recommendations: 1) that the appointment of the department editors be left to the editor; that they be appointed initially for a one-year term and then for a three-year term if mutually satisfactory; that one biology editor and the physical science editor be dropped and two additional mathematics editors be appointed; 2) that controversial book reviews be reviewed by two people; 3) that a similar meeting of department editors be held next year and in succeeding years; 4) that the editors be allowed to change the style of type for *Journal* headings if it can be done at no increase in cost. Read moved, Gourley seconded, that the recommendations be received and filed and that the board approve the fact that these items are in the province of the *Journal* editor. Carried.

Mr. Mallinson further recommended that the board appropriate money in the next budget for binding issues of the *Journal* from the first issue through 1957, present bindings now deteriorating rapidly. Hauswald moved, Read seconded, that this recommendation be approved. Carried.

On motion by Read, seconded by Bos, the date of the spring board meeting was set for Saturday, April 26. Carried.

Mr. Hardy suggested the need for an overall policy on publicity. Read moved, seconded by Bos, that the president be empowered to appoint a standing continuing public relations committee. Carried.

Mr. Hardy was asked to give a summary of local arrangements committee's work for this convention and to pass this file on to the new local arrangements chairman and to file a duplicate copy with the Association secretary.

In the discussion of the appointment of a new secretary it was agreed that the present secretary carry through the work until after the spring board meeting, at which meeting a new secretary is to be selected.

It was moved by Conrey, seconded by Bos, that the board adopt a resolution to continue the use of the River Forest State Bank as the depository for the

Association funds and that the signatures of the president and treasurer be required for withdrawal of such funds. Carried:

Miss Hach presented two recommendations of the present Policy Committee:

1) "The Policy and Resolutions Committee feels it is important for the effective functioning of this body to have a clarification as to its responsibilities and duties. It is recognized that the membership of the Policy and Resolutions Committee has been organized in such a way that it provides the possibility of significant contributions and service to the organization. The By-Laws Article V, Section VII states:

> 'The Policy and Resolutions Committee shall consist of six (6) members. Each member shall serve three years. Two members shall be chosen annually by the President to replace the two whose terms are about to expire. One of those chosen annually must be from the Board of Directors. The President will annually designate the chairman of this committee. The Chairman so selected shall have been a member of the committee for at least one year.'

This provides for continuity which is so important for the effectiveness of this committee. We feel that this matter of clarification as to responsibilities and duties is important enough to warrant action at this meeting or at the earliest possible date."

2) The Policy and Resolutions Committee feels it is essential that definite action be taken by the Board for the advancement and improvement of science and mathematics teaching. We recommend that the report of the Project and Research Committee of Nov. 1956 and all previous reports of this nature be reviewed and considered as a basis for possible action."

In a discussion concerning the functions and responsibilities of the Policy and Resolutions Committee the secretary was asked to consult the records for the past 8 or 10 years to find any definition of such duties as may have been given in the past and any reports pertaining to the work of past committees. It was also requested that the secretary send copies of the Nov. 22, 1956 report of the Project and Research Committee to all officers and board members.

Ayre moved, Hardy seconded, that the two recommendations submitted by the Policy and Resolutions Committee be approved. Carried.

It was moved by Conrey that in the event that finances permit the board authorize the Policy and Resolutions Committee to come to a meeting on the same basis of compensation as board members attending the spring board meeting. Seconded by Gourley and carried.

The meeting adjourned on motion at 4:05 P.M.

Respectfully submitted,
VIRGINIA TERHUNE
Secretary, CASMT

PLAN TO USE NEW FUELS TO PRODUCE OLD FUELS

The use of atomic-age sources of heat to produce traditional fuels was suggested to a meeting of the American Institute of Chemical Engineers by two Government engineers.

The use of nuclear reactors to supply the high temperatures needed to convert coal to gaseous and liquid fuels, was recommended by R. Carson Dalzell, chief of the branch of engineering development in the U. S. Atomic Energy Commission's Division of Reactor Development and James P. McGee, mechanical engineer in the U. S. Bureau of Mines' branch of coal gasification, Division of Solid Fuels Technology.

A drawback to commercial gasification of coal for use as fuel in other forms has been the cost of producing the necessary high temperatures. The Government engineers outlined a system that would call on nuclear reactor heat to gasify low-grade coal at 1,800 to 2,000 degrees Fahrenheit and convert high grade coal at temperatures above 2,000 degrees. The resulting gas could be burned as fuel, or could be used to produce liquid fuels and chemicals.

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING
San Diego State College, San Diego, Calif.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, San Diego State College, San Diego, Calif.

SOLUTIONS AND PROBLEMS

Note: Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2569. *Bernard Bjork, International Falls, Minn.*

2570. *A. R. Haynes, Tacoma, Wash.*

2593. *Proposed by Cecil B. Read, Wichita, Kansas.*

At the beginning of the Christian era, one dollar was invested at five per cent, compounded annually. Compare the present value of this investment with that of a solid ball of gold, the size of the earth.

Solution by W. R. Talbot, Jefferson City, Missouri

At the end of 1956 years (maybe 1957 would be better as there was no year 0 A.D.), the value of the dollar investment would be

$$A = 1.05^{1956},$$

which is readily evaluated by logarithms.

$$\text{Log } A = 1956 \log 1.05 = 1956 \times .02119 = 41.44764 \text{ and } A \ \$2.8 \times 10^{41}.$$

Taking radius of earth as 4000 miles, volume of earth in cubic feet is

$$V = \frac{4}{3}\pi(4000 \cdot 5280)^3$$

Water weighs 62.4 pounds per cubic foot and gold is 19.3 times as heavy as water. The price of gold is taken as \$35 per ounce or \$35×16 per pound. By 1

$$\text{Value of gold} \quad V \times 62.4 \times 19.3 \times 35 \times 16 \text{ dollars}$$

By logarithms

$$\log 4 = \quad .60206$$
$$\log \pi = \quad .49715$$
$$3 \log 4000 = 10.80618$$

$$\begin{aligned} 3 \log 5280 &= 11.16789 \\ \log 62.4 &= 1.79518 \\ \log 19.3 &= 1.28556 \\ \text{log } 16 &= 1.20412 \\ \text{log } 35 &= 1.54407 \\ \text{colog } 3 &= \underline{9.52288-10} \\ \text{Log Value} &= 28.42509 \end{aligned}$$

Value of gold is about 2.66×10^{28} The dollar investment is roughly ten million million times as valuable as the ball of gold the size of the earth.

Solutions were also offered by R. A. Atkins, Brooklyn, N.Y.; H. E. Christian, Oxford, Mass.; James Means, Huston-Tillotson College; Peter Speltz, Gardena, Calif.; and the proposer.

2594. *Proposed by Brother Felix John, Philadelphia, Pa.*

Show that if $a(b-c)x+b(c-a)xy+c(a-b)y^2$ is a perfect square, the quantities a, b, c are in harmonical progression.

Solution by Walter R. Talbot, Jefferson City, Missouri

The quantities a, b, c are in harmonic progression if their reciprocals are in arithmetic progression; i.e.

$$\frac{1}{c}-\frac{1}{b}=\frac{1}{b}-\frac{1}{a} \quad \text{or} \quad ab+bc=2ac.$$

The quadratic function $Ax^2+Bxy+Cy^2$ is a perfect square if $B^2-4AC=0$. For the given function, we get

$$b^2(c-a)^2-4ac(a-b)(b-c)=0$$

which expands and collects to

$$b^2c^2+a^2b^2+4a^2c^2+2b^2ac-4a^2bc-4c^2ab=0.$$

This is simply $(ab+bc-2ac)^2=0$, the square of the condition that a, b, c be in harmonical progression.

A solution was also offered by James Means, Huston-Tillotson College; and the proposer.

2595. *Proposed by L. M. Ridder, Exeter, N.H.*

a) Find a three digit number which when multiplied by 2 reverses its digits. (Hint: there are no such numbers in the decimal system.)

b) Find a general formula for the digits and number base of a many-digit number which when multiplied by k will reverse its digits.

Solution by W. R. Talbot, Jefferson City, Missouri

Consider the general case. Let the digits be a's, the base B, the multiplier k, and the carry-over amounts c's. The given relation is

$$k(a_1B^n+a_2B^{n-1}+a_3B^{n-2}+\cdots+a_{n-1}B^2+a_nB+a_{n+1})=a_{n+1}B^n+a_nB^{n-1}+\cdots+a_2B+a_1.$$

or

$$(ka_1-a_{n+1})B^n+(ka_2-a_n)B^{n-1}+\cdots+(ka_n-a_2)B+(ka_{n+1}-a_1)=0. \tag{1}$$

Taking the coefficients in (1) as identically zero leads to $k=1$ or a negative value for an a; so the coefficients are not identically zero. We can make (1) zero by writing it in the form

$$(-c_n)B^n+(c_nB-c_{n-1})B^{n-1}+(c_{n-1}B-c_{n-2})B^{n-2}+\cdots$$
$$+(c_3B-c_2)B^2+(c_2B-c_1)B+c_1B=0. \tag{2}$$

Equating corresponding coefficients in (1) and (2), we get from opposite ends of both lines

$$ka_1 - a_{n+1} = -c_n \qquad ka_2 - a_n = c_nB - c_{n-1}$$
$$ka_{n+1} - a_1 = c_1B \qquad ka_n - a_2 = c_2B - c_1.$$
$$ka_3 - a_{n-1} = c_{n-1}B - c_{n-2}$$
$$ka_{n-1} - a_3 = c_3B - c_2 \quad \text{etc.}$$

Assuming $c_1 = c_2 = c_3 = \cdots c_n - 1 = c_n$, and solving the pairs of equations, we get

$$a_1 = \frac{c_1(B-k)}{k^2-1}, \qquad a_{n+1} = \frac{c_1(kB-1)}{k^2-1}, \qquad a_2 = \cdots = a_n = \frac{c_1(B-1)(k+1)}{k^2-1}$$

Both a_1 and a_{n+1} will be integral if $B = (k^2-1)g + k$. Then we have

$$B = (k^2-1)g + k, \quad a_1 = c_1g, \quad a_2 = a_3 = \cdots a_n = c_1[(k+1)g+1], \quad a_{n+1} = c_1(kg+1) \quad (3)$$

where g is an integer. If $k = 2$, it is obvious that c_1 must be 1 unless $a_2 > B$.

$$k=2 \quad B = 3g+2 \quad a_1 = g \quad a_2 = a_3 = \cdots = a_n = 3g+1 \quad a_{n+1} = 2g+1 \qquad (4)$$

Some solutions for $k = 2$ are

g	Base	Number	g	Base	Number
1	5	14444 · · · 443	2	8	277777 · · · 7775
3	11	3*tttt* · · *tt*7	4	14	4*TTTTTTTT* · · *TTT*9

where $t = 11-1$ and $T = 14-1$. For larger values of k, $c_1 = 1, 2, 3, \cdots, k-1$. If $k = 3$, we have

$k=3 \quad B = 8g+3, \quad c_1 = 1$, number is 1555 · · · 5554 with $g = 1$ and
$c_1 = 2$ 2*tttt* · · *tt*8 with $g = 1$ and $t = 11-1$

$k=5 \quad g=1 \; B=29 \quad c_1 = 1$, number is 1777 · · 776 $c_1 = 2$ 2*ffff* · · *fffv*

$c_3 = 3$ 3*hhhh* · · *hhhe* $c_4 = 4$ 4*wwwwww* · · *wwwb*

where $f = 14$, $v = 12$, $h = 21$, $e = 18$, $w = 28$, and $b = 24$ in the decimal scale.

Suppose, however, that $c_n = 0$ and the other c's equal c_1. Then

$$a_1 = \frac{c_1B}{k^2-1}, \quad a_{n+1} = \frac{kc_1B}{k^2-1}, \quad a_2 = \frac{c_1(B-1-k)}{k^2-1}, \quad a_n = \frac{c_1(kB-k-1)}{k^2-1},$$
$$a_3 = a_4 = \cdots = a_{n-1} = \frac{c_1(B-1)}{k-1}$$

A value cannot be assigned to B immediately to make all a's integral, but if we let $c_1 = k-1$, we may have $B = (k+1)g$ where g is an integer. Then

$$B = (k+1)g, \; a_1 = g, \; a_2 = g-1, \; a_3 = a_4 = \cdots = a_{n-1} = (k+1)g-1, \; a_n = kg-1, \; a_{n+1} = kg. \quad (5)$$

Some solutions are

g	k	B	Number
1	2	8	1022222 · · 22212
2	2	6	2155555 · · 55534
3	5	18	32*ssssss* · · *sssdz* where $s = 17$, $d = 14$, and $z = 15$.

In summary, one type of solution (4) was found for three-digit numbers with $k = 2$. For many-digit numbers, two types of solutions were found: (3) and (5).

2596. *Proposed by Frank Peaslee, Cooperstown, New York.*

A rancher bought steers for 25 dollars the head, and cows for 26 dollars each. How many of each could he purchase for 1000 dollars?

Solution by Robert A. Atkins, Brooklyn, New York

If we let the number of steers be represented by the letter s and the number of cows by c, the above conditions lead to the equation

$$25s+26c=1000$$

This is an example of a Diophantine equation—an equation of more than one unknown which can be solved because the solutions are integral. To effect a solution, it is helpful to solve for one of the unknowns in terms of the other:

$$s=\frac{1000-26c}{25}$$

or

$$s=40-\frac{26}{25}c$$

The only possible values of c which will give positive integral values of s are 0 and 25. There are, therefore, two solutions to this problem:

40 steers and no cows
14 steers and 25 cows

Solutions were also offered by Lionel Chagrin, Brooklyn, N.Y.; Herbert Leifer, Verona, Pa.; James Means, Austin, Texas; J. P. Phillips, Louisville, Ky.; Bernard Pleimann, Gradena, Calif.; and W. R. Talbot, Jefferson City, Mo.

2597. *Proposed by John Satterly, Toronto, Canada.*

Show that in a plane triangle ABC whose sides a, b, c are in the ratio 2.8/1.7/2.5, the line NIU joining N, the center of the nine-point circle, I the incenter, and U the Feuerbach point, is parallel to the median drawn from C. (Reference may be made to Fig. 1, p. 520, October 1956 issue of SCHOOL SCIENCE AND MATHEMATICS.)

Solution by W. R. Talbot, Jefferson, City Missouri

A triangle of the given shape may be formed from two triangles of sides 20, 15, 25 and 8, 15, 17 with 15 as the common altitude. Then the triangle may be $A(20\ 15)$, $B(0, 0)$, and $C(28, 0)$. The orthocenter H lies on $x=20$ and the circumcenter O on $x=14$. The nine-point center N, being the mid-point of HO must have co-ordinates $(17, k)$ where k is to be found. Two points on the nine-point circle are $A'(14, 0)$ and $C'(10, 15/2)$ mid-points of BC and AB respectively. With $NA'=NC'$, we have

$$3^2+k^2=7^2+\left(k-\frac{15}{2}\right)^2 \quad \text{or} \quad k=77/12.$$

To find I, we use $r=S/p$ where S is the area, p the semi-perimeter, and r the inradius. We find $S=210$, $p=35$, and $r=6$. Then let I be $(h, 6)$. The slope of the bisector of angle B is given by

$$\tan\frac{B}{2}=\left(\frac{1-\cos B}{1+\cos B}\right)^{1/2}$$

where $\cos B=4/5$. The desired slope is $1/3$ and the bisector of angle B is $3y=x$. With $(h, 6)$ on this line, we get the incenter $I(18, 6)$. The equation of NI is $5x+12y=162$, which has the same slope as CC': $-5/12$.

The Feuerbach point is the point at which the nine-point circle is tangent to the incircle. We shall show that the line NI meets these two circles in the same point. The nine-point circle is

$$(x-17)^2+\left(y-\frac{77}{12}\right)^2=\left(\frac{85}{12}\right).$$

The incircle is

$$(x-18)^2+(y-6)^2=36.$$

NI meets both circles in the common point

$$\left(\frac{306}{13}, \frac{48}{13}\right).$$

Then N, I, U for triangles of the specified shape lie on a line parallel to the median drawn from C.

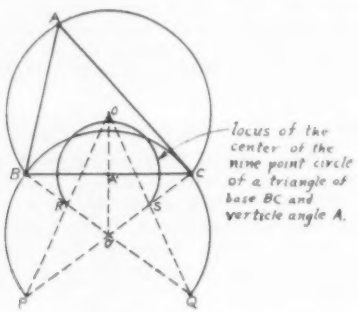
2598. *Proposed by Earl Haines, Baton Rouge, La.*

Given the base and the vertical angle of a triangle, find the locus of its nine-point circle.

Solution by Julian H. Braun, San Diego, Calif.

Let BC be the base of the triangle, A the angle opposite the base, and O the circumcenter. Let the base be bisected at A'. Let O' be the reflection of O in the chord BC. Then it follows from a known theorem that the locus of the orthocenter is the arc $PBCQ$ of the circle with center O' and radius $O'B$ where P and Q are the endpoints of diameters $CO'P$ and $BO'Q$. (See, for example, David R. Davis *Modern College Geometry*, 1954, ed., pp. 39–40.) Since the center of the nine point circle bisects the line joining the circumcenter to the orthocenter, its locus is the greater arc RS of the circle with center at A' and radius $A'R=\frac{1}{2}O'P$ as shown.

A solution was also offered by W. R. Talbot, Jefferson City, Mo.



STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

For this issue the Honor Roll appears below.

2590. *Nathaniel Queen, Brooklyn, N.Y.*

2592. *L. R. Wilson, Toronto, Canada.*

2593. *Joseph Bavaria, Faust Capobianco, Elinda Figlioli, Filomena Pagano, Philip Sabetti, Paul Schwork, all of Pius X. High School, Roseto, Pa.*

2596. *Donald Rose, Wantagh, N.Y.*

2596. *David Wilson, Toronto, Canada.*

2593. *Dave Ramsel, Serra High School, Gardena, Calif.*

2596. *John Parish, Palas Verdes Est., Calif.*

PROBLEMS FOR SOLUTION

2611. *Proposed by Murray S. Klamkin, Lawrence, Mass.*

Determine the maximum area bounded by three mutually tangent congruent parallel ellipses.

2612. *Proposed by Julian H. Braun, San Diego, Calif.*

Each side of an equilateral triangle is divided into n equal parts and lines are drawn parallel to the sides and joining the points of division. Find, as a function of n, the total number of regular hexagons within the figure. (The number of triangles in this figure is the subject of Problem 2130, SCHOOL SCIENCE AND MATHEMATICS, 1949, pp. 426.)

2613. *Proposed by C. W. Trigg, Los Angeles, Calif.*

Show how to dissect a non-equilateral triangle by straight cuts into three pieces which can be arranged to form two triangles similar to the given triangle.

2614. *Proposed by C. W. Moore, San Diego, Calif.*

An Explorer has to cross a desert 8,000 miles in extent. He has a jeep which can carry his supplies and 200 gallons of gasoline. His fuel consumption averages 20 miles per gallon. How should he proceed in setting up his caches of gasoline so as to use the least amount of gasoline in crossing the desert?

2615. *Proposed by J. W. Lindsey, Amarillo, Texas.*

How many square miles of the earth's surface can be seen from an airplane at an elevation of 10,000 feet? Take 4,000 miles as the radius of the earth.

2616. *Proposed by James H. Means, Austin, Texas.*

With few exceptions the ancient Egyptians had only unit fractions. (A unit fraction is a fraction with one as numerator and an integer as denominator.) Write 2/7 as a sum of a finite number of distinct, positive, unit fractions.

BOOKS AND TEACHING AIDS RECEIVED

RESOURCE LITERATURE FOR SCIENCE TEACHERS, John S. Richardson, Editor. Paper. Pages iv+65. 21×27.5 cm. 1957. College of Education, The Ohio State University, Columbus, Ohio. Price $1.00.

IMPROVING READING IN THE JUNIOR HIGH SCHOOL, Anor Jewett, Editor. Bulletin 1957, No. 10. Paper. Pages v+165. 15×23 cm. 1957. Office of Education, U. S. Department of Health, Education and Welfare, Washington, D. C. Price 60¢.

SHOULD YOUR CHILD BECOME A SCIENTIST? by John S. Lampe. Paper. 13 pages. 12.5×18 cm. 1957. Eastman Kodak Company, 343 State Street, Rochester 4, New York. Free.

AN ENGINEERING CAREER FOR YOUR SCHOOL-AGE CHILD, by John S. Lampe. Paper. 15 pages. 12.5×18 cm. 1956. Eastman Kodak Company, 343 State Street, Rochester 4, New York, Free.

NUTRITIONAL EVALUATION OF COFFEE, by L. J. Teply and R. F. Prier, *Wisconsin Alumni Research Foundation, Madison 5, Wisconsin.* Paper. 6 pages. 15×23 cm. 1957. The Coffee Brewing Institute, Inc., 551 5th Avenue, New York 17, N.Y.

CHEMICAL STUDY OF COFFEE FLAVOR, by Robert L. Clements and F. E. Deatherage, *Department of Agricultural Biochemistry, The Ohio State University, Columbus, Ohio.* 11 pages. 15×23 cm. 1957. The Coffee Brewing Institute, Inc., 551 5th Avenue, New York 17, N. Y.

COFFEE SOLUBLES AND BEVERAGE ACCEPTANCE, by Ernest E. Lockhart, Ph.D., *Scientific Director, Coffee Brewing Institute, Inc.* Paper. 13 pages. 15×23 cm. 1957. The Coffee Brewing Institute, Inc., 551 5th Avenue, New York 17, N.Y.

AIRCRAFT ANNUAL 1958, John W. R. Taylor, Editor. Cloth. 96 pages. 18.5×24 cm. 1957. Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $6.00.

PRINCIPLES OF ELECTRICAL MEASUREMENTS, by H. Buckingham, *Head of the Electrical Engineering Department, Loughborough College of Technology,* and E. M. Price, *Senior Lecturer in Electrical Engineering, Bradfrd Technical College.* Cloth. Pages xxiii+600. 14.5×21.5 cm. 1957. Philosophical Library, Inc., 15 E. 40th Street, New York 16. N.Y. Price $15.00.

SOVIET EDUCATION FOR SCIENCE AND TECHNOLOGY, by Alexander G. Korol. Cloth. Pages xxv+513. 15×23 cm. 1957. Published jointly by The Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., 440 4th Avenue, New York 16, N. Y. Price $8.50.

EDUCATORS GUIDE TO FREE TAPES, SCRIPTS AND TRANSCRIPTIONS, FOURTH ANNUAL EDITION, 1958. Compiled and Edited by Walter A. Wittich, Ph. D., *Director, Bureau of Audio Visual Instruction, University of Wisconsin,* and Gertie Hanson Halsted, M. A., *Formerly, Director of Radio Workshop, Wisconsin State College, Stevens Point, Wisconsin.* Paper. Pages xii+206. 21.5×27.5 cm. 1958. Educators Progress Service, Randolph, Wisconsin. Price $5.75.

AN INEXPENSIVE SCIENCE LIBRARY, compiled by Hilary J. Deason, *Director, High School Science Libaray Program, American Association for the Advancement of Science.* Paper. 16 pages. 15×23 cm. 1957. American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington 5, D. C. Price 10¢.

ROCKET, by Air Chief Marshal Sir Philip Joubert De La Ferte. Cloth. 190 pages. 13.5×21 cm. 1957. Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $6.00.

TRIGONOMETRY, by Rolland R. Smith, *Co-ordinator of Mathematics, Public Schools, Springfield, Mass.,* and Paul P. Hanson, *Head of Mathematics Department, The Manlius School, Manlius, N. Y.* Cloth. Pages x+470. 15×23 cm. 1957. World Book Company, Yonkers-on-Hudson, N. Y.

SELECTED REFERENCES ON CONSERVATION EDUCATION FOR TEACHERS AND PUPILS. Paper. 18 pages. 14×21.5 cm. 1955. The Conservation Education Association, Eastern Montana College of Education, Billings, Montana. Price 15¢.

NUCLEAR SCIENCE IN THE CLASSROOM—A HANDBOOK FOR TEACHERS. Paper. 205 pages. 21×27.5 cm. 1957. The Department of Public Instruction, Lansing, Michigan.

THE EARTH'S STORY, by Gerald Ames and Rose Wyler. Cloth. 222 pages. 21×27 cm. 1957. Creative Educational Society, Mankato, Minnesota.

HOW TO DO AN EXPERIMENT, by Philip Goldstein, *Chairman, Department of Biology Abraham Lincoln High School, Brooklyn, New York.* Cloth. 192 pp. 14.5×21.5 cm. 1957. Harcourt, Brace and Company, 383 Madison Ave., New York 17, N. Y. Price $2.60.

THE FASCINATION OF NUMBERS, by W. J. Reichmann. Cloth. 176 pages. 13×20 cm. 1957. Essential Books, Inc., 16-00 Pollitt Dr., Fair Lawn, N. J. Price $4.00.

SCIENCE IN EVERYDAY LIFE, by Ellsworth S. Obourn, *Specialist in Science Education, United States Office of Education, Washington, D. C.*, Elwood D. Heiss, *Professor of Science, New Haven State Teachers College, New Haven, Connecticut*, and Gaylord C. Montgomery, *Instructor of Science, John Burroughs School, Clayton, Missouri*. Cloth. Pages xii+624 pp. 16.5×24 cm. 1958. D. Van Nostrand Co., Inc., 120 Alexander Street, Princeton, N. J. Price $4.68.

1957 SUPPLEMENT TO COLLEGE BOARD SCORES NO. 2, by Joshua A. Fishman. Paper. Pages vi+206. 16.5×24.5 cm. 1957. College Entrance Examination Board, c/o Educational Testing Service, Box 592, Princeton, N.J.

TEACHING, by William H. Burton, *Consultant, Oregon State Department of Education*, Vocational and Professional Monographs. Paper. 40 pages. 15×23 cm. 1957. Bellman Publishing Co., P.O. Box 172, Cambridge 38, Mass. Price $1.00.

ARCHIMEDES, by E. J. Kijksterhuis. Cloth. 422 pages. 15×22.5 cm. 1957. The Humanities Press, Inc., 303 4th Ave., New York 10, N. Y. Price $12.50.

BOOK REVIEWS

FUNDAMENTAL MATHEMATICS, by Leslie H. Miller, *The Ohio State University*. Paper 323 pages. 21×28 cm. 1957. Henry Holt and Co., 383 Madison Avenue, New York 17, N. Y. Price $3.50.

Whether the claim be justified or not, every college feels that many students enter the school with inadequate mathematical background. The question of providing a suitable course and text for such students is always present. The author has attempted to present what he calls elementary mathematics with the idea that some of the deficiencies can be corrected but at the same time "a student will feel that he is being treated as a mature individual." The range of topics considered is wide, possibly more than one would include in a single course. As indicative, but not exhaustive, one might mention: operations with integers including a discussion of the binary, trinary, and duodecimal systems, negative integers, prime numbers; measurements including some elementary geometry; common and decimal fractions; approximate computations; elements of algebra including not only considerable material that would be in a first year course but (in the later portion of the book) some material normally found in a second course in algebra; topics from the mathematics of finance including interest and annuity formulas and the use of tables; graphic methods including not only statistical graphs but the graphical solution of simultaneous equations; logarithms and some simple material on numerical trigonometry.

There is somewhat liberal use of colored ink both in the text and in the diagrams—whether this is necessary at the college level is a matter of opinion. Approximately 100 pages are of the work book or "tear-out" type. In some cases the room provided for problem solution is more than ample, in other cases it seems insufficient. Whether or not this type of book is desired is a matter for the individual instructor to determine. (At least, there are no usable second hand copies and more texts will be sold.)

There are wide variations in the level of maturity required as well as the degree of rigor. The "cook book" type of instruction predominates in many places—rules are given without any reason; at other spots there may be good explanation of the reason for the rule. In general the author has been careful in his restrictions on the use of a constant which may assume a value zero, being meticulous in avoiding division by zero. However, this is not a consistent practice. On page 56 one finds the statement "a rational number is one which can be expressed as

the quotient of two integers, except that the divisor cannot be zero." It seems to the reviewer that if the divisor is zero you cannot express the number as the quotient of two integers. In the definition of an identity (page 88) it is not made clear that we are restricting the letter or letters appearing in the equation to those values for which the expressions appearing have meaning. On page 20 the author has been unreasonably restrictive in requiring that a and b are different from zero; why, for example, in $(ab)^n = a^n b^n$ is the relationship invalid if either a or b (or both) should happen to be zero? In treating a complex number it is stated that given the number $a+bi$, for $a=0$ we have a pure imaginary, for $b=0$ a real number. What if both a and b are zero? On page 56 it is stated "the value of a fraction is not changed if both numerator and denominator are either multiplied or divided by the same integer." What if the integer is zero?

Certain other points disturbed the reviewer. "For a given set of numbers the median is a number that has as many of the given numbers above as below it." It would appear ffom the definition that if we write in a vertical column the numbers 52, 12, 7, 13, and 14 then 7 satisfies the definition for a median. The definitions for zero and negative exponents are given on page 59 with no explanation of any reason why these definitions were selected. An answer to a problem on page 73 gives the implication that since a difference due to treatment with a drug is small (3 per cent) it should be attributed to chance or to error. It seems to the reviewer that more is involved here than it implied in the problem—the statistical problem of significance of a difference in particular. On page 28 in discussing the study of geometry [sic] there is a definite ambiguity as to what is meant by "amount of rotation about O needed to make the line AO coincide with line DO." There is no specification as to which line is rotated and more than one angle would satisfy the definition. The definition of a mantissa of a logarithm on page 201 does not agree with a later statement $\log 0.0246 = -1.6091$ which would imply the mantissa is .6091, contradicting a statement made later on in the page.

The listing of many of these points may seem quibbling over details. However, in the opinion of the reviewer the merit of the book could have been markedly increased by more careful phrasing. Whether or not the book is a satisfactory text depends markedly and obviously upon the particular course or remedial work under question.

CECIL B. READ
University of Wichita

CALCULUS WITH ANALYTIC GEOMETRY, by Richard E. Johnson, *Smith College*; and Fred L. Kiokemeister, *Mount Holyoke College*. Cloth. Pages xi+650. 15×23 cm. 1957. Allyn and Bacon, Inc., 41 Mt. Vernon Street, Boston 8, Mass. Price $7.95.

This text can be classified as somewhat more rigorous in nature than the majority of beginning calculus texts. Illustrative of this are: the extensive treatment of limits (about 18 pages in Chapter 4); the proof of the arc-length formula; the discussion of the boundedness of a continuous function. [This list is by no means exhaustive.]

The material on analytic geometry is largely isolated in four chapters, separated by chapters treating other material. In general, the discussion does not make much use of calculus concepts, but there are refreshing exceptions, as in the use of limits in the treatment of horizontal and vertical asymptotes.

Chapter 15 introduces the concept of vectors; chapter 20 covers differential equations to a greater extent than is customary in a beginning text, including treatment of second order linear equations, non-homogeneous equations, and a brief treatment of solution in series.

The supply of problems seems in most cases ample; answers, in the back of the text, are given for odd numbered exercises.

For the teacher seeking a text with stress on rigorous theory, without neglect of applications, this book must be considered. It might be adequate for a brief course in what is often called "advanced calculus."

No text will ever please everyone. Some will object to the use of the term "infinite limits"; others might wish a more adequate reason for the choice of the definition of the domain of the inverse trigonometric functions, (since the authors restrict the definition of function to one and only one value, the concept of "principal value" is unmentioned). Probably most such criticisms are matters of individual preference on the part of the teacher, and do not detract from the overall soundness of the text.

CECIL B. READ

NIELS HENRICK ABEL, MATHEMATICIAN EXTRARODINARY, by Oystein Ore. Cloth. 277 pages. 15×23 cm. 1957. University of Minnesota Press, Minneapolis, Minn. Price $5.75.

This biography of the brilliant Norwegian mathematician shows signs of extensive research. At times the style seems somewhat ponderous; quotations from letters at times seem overdone; nevertheless the book as a whole is very readable. It presents more details about Abel's life than would be available without much research. Certainly the book is recommended as supplementary material for the history of mathematics; it can be read and appreciated by any high school student.

CECIL B. READ

HEALTH AND FITNESS, Florence L. Meredith, *Late Professor of Hygiene and Public Health, Tuft's College*; Leslie W. Irwin, *Professor of Health Education, Boston University*; Wesley M. Staton, *Associate Professor of Health Education, Wayne State* University. 450 p. $4.20 D. C. Heath & Co., Boston 1957 (Third Edition)

This text, primarily intended for use at the high school level, is built around some nine major blocks which present subject matter relative to body structure, functioning and health principles for the individual as well as for the group.

Some teachers might question the degrees of relative emphasis and importance of the various chapters and units in terms of pages used. Nutrition for example is treated at length as is also the chapter on the choosing of a mate. Alcohol and tobacco are briefly discussed and there is little on sex hygiene.

On the other hand, the book is colorful throughout, has eye and interest appeal. The subject matter is authentic and up to date. The unit on cancer is outstanding. Study guides at the end of each chapter provide the teacher with stimulating material for extensive amplification of the various topics. Students will like this text.

MERRILL R. WISEMAN
Western Michigan University

CHEMISTRY-A BASIC SCIENCE, by John C. Hogg, *Chairman, Science Department and Harlan Page Amen Professor, The Phillips Exeter Academy, Exeter, New Hampshire*, Otis E. Alley, *Professor of Science, State Teachers College, Bridgewater, Massachusetts*, and Charles L. Bickel, *Instructor in Science, The Phillips Exeter Academy, Exeter, New Hampshire*. Cloth. Pages xi+801. 15×22.8 cm. 1957. D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, New Jersey. Price $4.68.

This is an attractive text for a high school chemistry course. There are many very excellent illustrations. The numerous lecture demonstrations ddscribed throughout the text will be useful to the teacher in planning the classroom presentation. Each chapter is amply supplied with questions and also with problems divided into groups A and B. The A group includes the simpler problems and the B group the more difficult. Answers are given to about ½ of the problems. A brief, well selected summary of "Things to Remember" is given at the end of each chapter. The text material is easily readable and within the comprehension of the average high school student.

Some of the explanations used in the test are perhaps too traditional. The Arrhenius theories of ionization and of acids and bases are used exclusively with no modifications based upon more recent observations and developments. The presentation of hydrolysis is somewhat old-fashioned. In the optional sections dealing with the structure of atoms in a long series and the rare earth elements, the presentation is rather confusing. An introduction of the orbital arrangements derived in modern quantum mechanics would have been more satisfying. In the treatment of electrolysis the electric current is defined as moving from positive to negative in a direction opposite to the flow of electrons. This convention is considered out-of-date by physicists today.

The book contains an excellent unit on Atomic Energy. The diagrams given in this unit are especially helpful. In general, the treatment is very clear. The book provides for students who need only a descriptive course as well as those who plan to continue their study of chemistry in college. Some provision for the exceptional student is made in the appendix. Except for the few out-of-date things mentioned above the text is a very good one.

ELAINE ZIMMERMAN
Western Michigan University
Kalamazoo, Michigan

FOUNDATION ANNOUNCES 108 SUMMER INSTITUTES FOR HIGH-SCHOOL AND COLLEGE TEACHERS OF SCIENCE AND MATHEMATICS

Approximately 5,000 high-school and 250 college teachers of science and mathematics will benefit during the summer of 1958 from teacher-training programs sponsored by the National Science Foundation at 108 summer institutes in 104 educational institutions.

Awards of the grants totaling $5,340,000 for the support of the summer institutes were announced by Alan T. Waterman, Director of the Foundation. Ninety-nine (99) of the institutes will be open only to high-school teachers of science or mathematics. Four will be open to both high-school and college teachers and five to college teachers only. Roughly 5,000 high-school teachers and 250 college teachers will be enabled to participate through stipends and tuition provided by the National Science Foundation. Twelve institutes offering courses in radiation biology for high-school teachers are being jointly sponsored by the Foundation and the Atomic Energy Commission.

"The summer-institutes program of the Foundation is in step with current plans for strengthening the training of scientists in the United States," said Dr. Waterman. "Good science teachers are apt to be the first to stimulate an interest in science among our young people in secondary schools. But if instruction is not stimulating, and contains outdated concepts, it tends to weaken youths' motivations toward science careers. Foundation-supported summer institutes provide opportunities for thousands of hard-pressed high-school science teachers to learn at first hand the rapidly advancing developments in today's science, mathematics, and engineering.

"A total of 108 summer institutes for 1958 will be established in 104 host institutions of higher learning, spread widely across the Nation in nearly every State.

The Foundation grants to each summer institute will cover costs of tuition and other fees for a specified number of teachers—from 20 to 100, the average size to be approximately 50. Most institutes will pay stipends directly to participating teachers at a maximum rate of $75 per week. Additional allowances for dependents to a maximum of four, and for travel, are provided.

Inquiries and applications for participation should be addressed to directors of the individual institutes named in the following lists which also designate the host institution and eligible teachers. Unless otherwise indicated, the institute director is located at the host institution.

Host Institution	Director	Teaching Fields of Participants for Whom Institute Is Designed						
		Biology	Chemistry	Earth Science	General Science	Mathematics	Physics	Radiation Biology
Alabama								
Alabama College	Paul C. Bailey, Biology Dept.	x	x		x		x	
Alabama, University of	Charles K. Arey, College of Education	x	x	x	x	x	x	
Tuskegee Institute	W. Edward Belton, Chemistry Dept.		x					
Alaska								
Alaska, University of	Alfred M. Bork, Physics Dept.	x	x			x	x	
Arizona								
Arizona, University of	Millard G. Seeley, Chemistry Dept.				x	x		
Arkansas								
Arkansas, University of	Lowell F. Bailey, Botany & Bacter. Dept.	x	x		x	x	x	
California								
California, Univ. of (Berkeley)	Robert A. Rice, University Extension	x	x	x	x		x	
California, Univ. of, Medical Center (Los Angeles)	Raymond L. Libby, Radiology Dept.	x	x		x		x	x
**Claremont College	Willis E. Pequegnat, Zoology Dept.	x			x			
San Jose State College	Wilbur Sprain, Natural Science Dept.				x			
Southern California, Univ. of	Charles S. Copeland, Chemistry Dept.		x				x	
Colorado								
Colorado College	Lewis N. Pino, Cutler Hall	x	x		x	x	x	
Denver, University of	Byron E. Cohn, Physics Dept.		x				x	
Connecticut								
Connecticut, University of	David J. Blick, Physics Dept.						x	
Wesleyan University	Vincent W. Cochrane, Biology Dept.	x	x	x	x	x	x	
Delaware								
Delaware, University of	Cecil C. Lynch, Chemistry Dept.	x	x		x	x	x	
District of Columbia								
American University	Leo Schubert, Chemistry Dept.		x				x	
Howard University	Marie C. Taylor, Botany Dept.							x
Florida								
Florida State University	J. Paul Reynolds, Col. of Arts and Sci.	x	x		x	x	x	
Georgia								
Atlanta University	K. A. Huggins, Chemistry Dept.	x	x			x		
Georgia, University of	T. H. Whitehead, Chemistry Dept.	x	x		x	x	x	
Hawaii								
Hawaii, University of	John J. Naughton, Chemistry Dept.	x	x		x	x	x	

For High-School Teachers Only, except as follows:
* For College Teachers Only.
** For High-School and College Teachers.

Host Institution	Director	Teaching Fields of Participants for Whom Institute Is Designed						
		Biology	Chemistry	Earth Science	General Science	Mathematics	Physics	Radiation Biology
Idaho								
Idaho, University of	W. H. Cone, Physical Sciences Dept.	x	x			x	x	
Illinois								
Chicago, University of	Alfred L. Putnam, Eckhart Hall 411					x		
*Illinois, University of	D. M. Henderson, Geology Dept.			x				
Illinois Wesleyan Univ.	Wayne W. Wantland, Science Division	x	x			x	x	
Indiana								
Indiana University	Shelby D. Gerking, Zoology Dept.	x						
Notre Dame, University of	Arnold E. Ross, Mathematics Dept.					x		
Purdue University	R. R. Armacost, Biol. Scis. Dept.	x						
Iowa								
Drake University	R. R. Haun, Physical Science Dept.	x	x		x		x	
Iowa State Col. of A & M Arts	J. A. Greenlee, Science Division	x	x		x	x	x	
Iowa State Teachers College	Dorothy C. Matala, Biology Dept.				x			
Kansas								
Kansas State Teachers College	Otto M. Smith, Chemistry Dept.	x	x	x	x		x	
**Kansas, University of	G. Baley Price, Mathematics Dept.					x		
Kentucky								
Murray State College	Alfred M. Wolfson, Biol. Scis. Dept.	x	x	x	x		x	
Louisiana								
Dillard University	Edward E. Riley, Jr., Nat. Sci. Div.	x	x					
Louisiana State University	H. B. Williams, Chemistry Dept.	x	x			x	x	
Maine								
Bowdoin College	Noel C. Little, Physics Dept.						x	
Colby College	Evans B. Reid, Chemistry Dept.	x	x			x	x	
Maryland								
Maryland, University of	Joshua R. C. Brown, Zoology Dept.	x	x		x		x	
Morgan State College	Thomas P. Fraser, Sci. Educ. Dept.	x	x	x	x	x	x	
Massachusetts								
**Harvard University	A. K. Solomon, Harvard Medical. Sch.							x
Tufts University	M. Kent Wilson, Chemistry Dept.		x			x	x	
*Williams College	Samuel A. Matthews, Biology Dept.	x						
Worcester Polytechnic Inst.	Richard F. Morton, Physics Dept.						x	
Michigan								
*Michigan State University of A & M Arts	F. B. Dutton, Science and Mathematics Teaching Center		x			x	x	
Northern Michigan College	Holmes Boynton, Mathematics Dept.	x	x		x	x	x	
Wayne State University	Arthur J. Vorwald, Col. of Medicine							x
Western Michigan University	Charles H. Butler, Mathematics Dept.					x		
Minnesota								
Carleton College	Kenneth O. May, Math. & Astron. Dept.					x		
Minnesota, Univ. of (Duluth)	W. R. McEwen, Sci. and Math. Div.	x	x		x	x	x	

Host Institution	Director	Teaching Fields of Participants for Whom Institute Is Designed						
		Biology	Chemistry	Earth Science	General Science	Mathematics	Physics	Radiation Biology
Minnesota, Univ. of (Minneap.)	J. W. Buchta, Physics Dept.						x	
Minnesota, Univ. of (Minneap.)	William H. Marshall, Zoology Dept.	x						
Mississippi								
Mississippi, University of	George Vaughan, Chemistry Dept.	x	x		x	x	x	
Missouri								
Missouri School of Mines and and Metallurgy	Harold Q. Fuller, Physics Dept.		x		x	x	x	
St. Louis University	Theo. A. Ashford, Chemistry Dept.		x					
Montana								
**Montana State College	L. O. Binder, Jr., Chemistry Dept.		x					
Montana State University	G. B. Castle, Biology Dept.	x						x
Nebraska								
Nebraska, University of	Walter E. Militzer, College of Arts and Sciences	x	x			x	x	
New Hampshire								
New Hampshire, University of	Harold. A. Iddles, Chemistry Dept.		x				x	
New Jersey								
Rutgers University	Emory P. Starke, Mathematics Dept.					x		
New Mexico								
New Mexico, Highlands Univ.	Lora Mangum Shields, Biology Dept.	x	x					
New Mexico, University of	Harold O. Ried, Director of the Summer Session							x
New York								
Adelphi College	Howard A. Robinson, Physics Dept.		x					x
Buffalo, University of	Harriet F. Montague, Math. Dept.					x		
Cornell University	Richard B. Fischer, Rural Educ. Dept.			x				
Rensselaer Polytechnic Inst.	Edwin Brown Allen, Mathematics Dept.				x			
Union College	George Reed, Chemistry Dept.	x	x			x	x	
North Carolina								
Duke University	Henry S. Roberts, Jr., Zoology Dept.							x
Duke University	W. M. Nielsen, Physics Dept.	x	x			x	x	
N. Car. Coll. at Durham	William H. Robinson, Physics Dept.	x	x			x		
North Carolina, Univ. of	Victor A. Greulach, Botany Dept.	x	x	x	x	x	x	
North Dakota								
North Dakota, University of	J. Donald Henderson, Physics Dept.		x		x	x	x	
Ohio								
Antioch College	James F. Corwin, Chemistry Dept.				x			
Case Institute of Technology	R. G. Weast, Chemistry Dept.		x					
Oberlin College	Wade Ellis, Mathematics Dept.					x		
Ohio University	L. P. Eblin, Chemistry Dept.		x			x	x	
Ohio Wesleyan University	Howard N. Maxwell, Physics Dept.		x		x		x	

Host Institution	Director	Teaching Fields of Participants for Whom Institute Is Designed						
		Biology	Chemistry	Earth Science	General Science	Mathematics	Physics	Radiation Biology
Oklahoma								
Oklahoma, University of	Horace H. Bliss, 61 Faculty Exchange				x			
Oregon								
*Oregon State College	Henry P. Hansen, Graduate School	x						
*Oregon, University of	Robert W. Morris, Biology Dept.	x						
Reed College	Kenneth E. Davis, Physics Dept.						x	
Pennsylvania								
Allegheny College	Robert E. Bugbee, Biology Dept.	x	x	x	x	x	x	
Bucknell University	Lester Kieft, Chemistry Dept.	x	x		x	x	x	
Lafayette College	Fred V. Roeder, Education Dept.		x				x	
Pennsylvania State University	William H. Powers, Arts and Science Extension	x	x	x	x		x	
Puerto Rico								
Puerto Rico, University of	F. Bueso, College of Natural Sciences				x	x		
Rhode Island								
Brown University	Elmer R. Smith, Teacher Training				x	x		
South Carolina								
Converse College	H. E. Shiver, Chemistry Dept.	x	x				x	
South Dakota								
State Univ. of South Dakota	Charles R. Estee, Box 57, Univ. Exchange	x	x		x	x	x	
Tennessee								
Oak Ridge Inst. of Nuclear Studies	Ralph T. Overman, Special Train. Div.		x				x	
Oak Ridge Inst. of Nuclear Studies	Ralph T. Overman, Special Train. Div.						x	
Tennessee Polytechnic Institute	G. B. Pennebaker, School of Arts and Scis.	x	x		x	x	x	
Texas								
Baylor University	Bryce C. Brown, Biology Dept.	x	x		x	x	x	x
Howard Payne College	Richard A. Eads, Science Division				x	x		
Southern Methodist Univ.	Joe P. Harris, Jr., Biology Dept.	x	x		x	x	x	
Stephen F. Austin State College	H. E. Abbott, Chemistry Dept.	x	x		x	x	x	
Utah								
Brigham Young University	Lane A. Compton, Physics Dept.							x
Vermont								
Vermont, University of	N. James Schoonmaker, Math. Dept.					x		
Virginia								
Virginia Polytechnic Institute	Thomas M. Hahn, Jr., Physics Dept.	x	x	x	x		x	
Virginia State College	Richard H. Dunn, Graduate Studies and Research				x			
Washington								
State Coll. of Washington	Alfred B. Butler, Physics Dept.	x	x	x	x	x	x	

West Virginia							
West Virginia, Univ.	J. K. Stewart, Mathematics Dept.		x		x	x	
Wisconsin							
Marquette University	Rezneat M. Darnell, Biology Dept.	x					
Ripon College	Robert S. Wilson, Physics Dept.			x	x	x	
Wisconsin, University of	H. Van Engen, Mathematics Dept.				x		
Wyoming							
Wyoming, University of	William B. Owen, Zoology Dept.	x					x
Wyoming, University of	W. Norman Smith, Mathematics Dept.				x		

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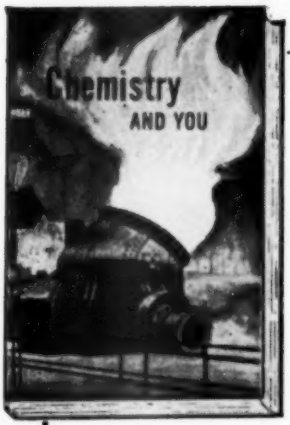

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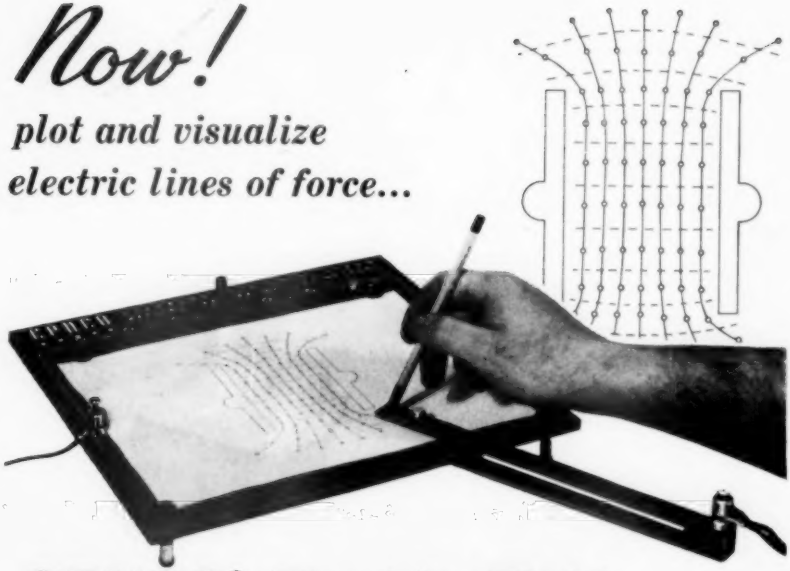

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